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THESIS

IDENTIFICATION OF BARRIERS TO MORE
EFFECTIVE AGRICULTURAL WATER MANAGEMENT
IN THE SALINAS RIVER VALLEY

by

Robert E. Pottberg

December, 1991

Thesis Co-Advisors:

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<p>The Salinas River Valley is currently in it's fifth straight year of drought. Goundwater is becoming increasingly more important to the economic future of this agriculturally dominated valley. Continued consumption of groundwater at the current rate threatens the economic and environmental furure of the Valley through excessive overdrafting of the underlying aquifer and through the phenomenon of "seawater intrusion." This thesis identifies the physical, economic, social and political barriers to more effective agricultural water management from the perspective of the individual grower, through the use of a comprehensive survey.</p> <p>This study will contribute to a better understanding of the major water conservation issues and barriers from the individual grower's perspective. It will provide useful information to decision makers in arriving at water conservation policies that are both equitable and in the best long term interest of the various water users of the Salinas River Valley. By exploring the multiple dimensions of specific issues, the perceived and real barriers and the perceptions of interested parties, this study will help foster better awareness, cooperation and communications between the county agency responsible for water resources management and the individual agricultural growers.</p>				
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Identification of Barriers to More
Effective Agricultural Water Management
in the Salinas River Valley

by

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Submitted in partial fulfillment
of the requirements for the degree of

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ABSTRACT

The Salinas River Valley is currently in it's fifth straight year of drought. Groundwater is becoming increasingly more important to the economic future of this agriculturally dominated valley. Continued consumption of groundwater at the current rate threatens the economic and environmental future of the Valley through excessive overdrafting of the underlying aquifer and through the phenomenon of "seawater intrusion." This thesis identifies the physical, economic, social and political barriers to more effective agricultural water management from the perspective of the individual grower, through the use of a comprehensive survey.

This study will contribute to a better understanding of the major water conservation issues and barriers from the individual grower's perspective. It will provide useful information to decision makers in arriving at water conservation policies that are both equitable and in the best long term interest of the various water users of the Salinas River Valley. By exploring the multiple dimensions of specific issues, the perceived and real barriers and the perceptions of interested parties, this study will help foster better awareness, cooperation and communications between the county agency responsible for water resources management and the individual agricultural growers.

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I. INTRODUCTION

A. GENERAL

The Salinas River Valley is currently in it's fifth straight year of drought. It is highly uncertain when the current drought will end, or whether the Salinas Valley will ever recover fully from it's devastating effects. During this period of drought, groundwater has become increasingly more important to the economic future of this agriculturally dominated valley. Continued consumption at the current rate threatens the economic and environmental future of the valley through excessive "overdrafting" of the underlying aquifer and the related phenomenon of "seawater intrusion." The agricultural industry is by far the largest user of water resources in the Salinas Valley. Therefore, the future of all communities within the Salinas River Valley will depend predominately on effective agricultural water management.

Gaining an understanding of the physical, economic, social, and political barriers to more effective agricultural water management from the individual grower's perspective is an essential element in the search for solutions to the current water problems. This research will provide decision makers with another part of the information necessary to find

solutions that are both equitable to all parties involved and in the best long-term interest of the Salinas Valley.

B. OBJECTIVES OF THE RESEARCH

The primary objective of this research is to acquire an understanding of agricultural water management issues and barriers to effective water management, as seen from the perspective of the individual grower or rancher. By exploring the multiple dimensions of specific water management issues, the perceived and real barriers to more effective agricultural water management, and the perceptions of interested parties, this study will help foster better awareness and cooperation between all of the competing water interests in the Salinas Valley. Identifying the barriers to more effective agricultural water management from the grower/rancher perspective, and communicating their concerns to decision makers through this research will aid in developing the cooperation necessary to solve the Valley's water problems. Helping to improve communications between the county agency responsible for Valley-wide water management and the individual agricultural growers and ranchers is one of the keys to the ultimate goal of providing for the current and future groundwater needs of all Salinas Valley water users.

C. RESEARCH QUESTION

An adequate, reliable supply of groundwater is vital to the agricultural community of the Salinas River Valley. In light of the importance of groundwater to the economic future of the valley, this thesis will address a number of vital questions.

The primary research question this thesis will address is:

- Why is it proving so difficult to implement more effective agricultural water management practices at the individual grower and rancher level?

Subsidiary research questions will include:

- What are some of the actual physical or technological constraints prohibiting individual growers from conserving additional groundwater?
- What financial considerations hinder individual growers most from conserving additional groundwater?
- What are the most important social barriers to more effective agricultural water management?
- What are the key political obstacles inhibiting better agricultural water management in the Salinas Valley?

D. SCOPE, LIMITATIONS AND ASSUMPTIONS OF THE RESEARCH

Groundwater from the Salinas River Valley aquifer is used by three principle groups. They are: agricultural water users; urban water users; and industrial water users. Of these three groups, the agricultural industry uses by far the largest amount. For this reason, agricultural groundwater use and particularly, agricultural groundwater use at the

individual grower level was the focus chosen for this research.

Currently, there has not been a great deal of research done in the area of identifying groundwater management issues and barriers to effective agricultural groundwater management at the individual grower and rancher level. This research used a written mail survey to gather data on groundwater management issues and barriers. The results of this thesis provide a better understanding of important groundwater issues, identify some of the major groundwater problems, document some of grower's main concerns and provide a useful source of information for understanding and resolving the barriers to more effective agricultural water management.

This research addressed the entire population of individual growers and ranchers within the Salinas Valley. The only limitation was that in the Salinas Valley there are numerous large corporate farms, each corporation managing farms of up to 6000 acres. These acres are split between multiple non-contiguous sites. It wasn't possible to obtain data from each individual corporate farm site, so survey data was instead obtained from the manager of each corporation's valley-wide operations.

This research makes only one broad assumption. As a result of the prolonged drought conditions, all agricultural growers and ranchers in Monterey County were required to submit a voluntary groundwater conservation plan for 1991.

Therefore, this research assumed that all growers and ranchers were aware of the worsening groundwater supply conditions and of the perceived general need to conserve the remaining available groundwater resources.

E. LITERATURE REVIEW AND METHODOLOGY

A previous thesis, completed in December of 1990 and entitled "Market Allocation Of Agricultural Water Resources In The Salinas Valley," stimulated my interest in agricultural water management issues. This interest led to extensive research in the Dudley Knox Library at the Naval Postgraduate School and the library of the Monterey County Water Resources Agency. Interviews with county officials and agricultural industry leaders broadened my understanding of the magnitude and complexity of water management issues, made worse by the current drought. With the knowledge gained from this process, the research questions were developed, and the scope of the research narrowed to focus on the predominant end users of groundwater resources in the Valley: the individual growers and ranchers.

Desiring responses from the broadest possible population of individual growers and ranchers within the Salinas Valley, a written mail survey was developed using the "Total Design

Method."¹ In arriving at a final survey, six drafts were tested on a total of fifteen members of the agricultural community, county officials, and academic advisors at the Naval Postgraduate School. Follow-on interviews were also conducted with several people such as: Mr. Lawrence Porter of the Salinas Valley Water Advisory Commission, Mr. Bill Barker of the Monterey County Farm Bureau, Mr. Ted Mills of the Monterey County Water Resources Agency, and Dr. Tom Moore of the Naval Postgraduate School. This helped to refine the final mail survey, and resulted in a product that conformed to the "Total Design Method" of conducting a mail survey.

F. DEFINITIONS AND ABBREVIATIONS

The following is a list of definitions and abbreviations for terms that are frequently used in this thesis:

- Monterey County Water Resources Agency (MCWRA) is the agency responsible for management of water resources, flood control, and maintenance of water storage reservoirs for all of Monterey County.
- Monterey County Board of Supervisors (MCBS) is the board of elected officials responsible for enacting local legislation affecting the use of water resources within Monterey County.
- Salinas Valley Water Advisory Commission (SVWAC) is a commission appointed by the Monterey County Board of

¹ The Total Design Method is a method of mail survey design which focuses on the identification of each aspect of the survey process (even the minute ones) that may affect response quantity or quality, and shapes them in a way that will encourage maximum response.

Supervisors for the purpose of advising the board on agricultural water matters.

- Central Coast Agricultural Task Force (CCATF) is an independent, non-profit task force comprised of ten, agricultural member organizations. It exists for the purpose of monitoring local and regional water issues and regulations, primarily within Monterey County.
- Monterey County Farm Bureau (MCFB) is a nonprofit organization consisting of voluntary members representing diverse agricultural commodities throughout the county.
- Salinas Valley Water Coalition (SVWC) is an independent, non-profit coalition of growers, interested in the protection of the agricultural water rights and interests.
- Board of Directors of the Monterey County Water Resources Agency (BDMCWRA) is the board appointed by and responsible to the County Board of Supervisors for the oversight of water related policies of the Monterey County Water Resources Agency.
- Salinas Valley Groundwater Basin (SVGB) is the single hydrologic unit serving the Salinas Valley. It is commonly divided into four subunits: Pressure, Eastside, Forebay, and Upper Valley.

G. SUMMARY OF FINDINGS

The following is a summary of the most important findings of this research:

- Financial factors, or monetary constraints, were the driving force behind demonstrated individual attitudes and behavior.
- Financial factors were the overriding impediment to overcoming the physical or technological constraints which limit more effective groundwater utilization.
- The prolonged drought has had significant impacts on profit margins, which has reduced the potential for further gains in groundwater conservation, due to the unavailability of funds at the individual grower and rancher level.

- Incentives to make further gains in groundwater conservation do not exist at the present time. It is becoming increasingly difficult to secure funds to invest in groundwater conservation projects.
- "Cost sensitivity" to water conservation initiatives at the individual grower and rancher level has lead to a general fear of government involvement in solving the Valley's groundwater problems.
- Short-term interests are presently taking priority over the long-term interests of the numerous affected parties who are concerned with the future of the Salinas Valley's groundwater supplies.
- The Salinas Valley growers and ranchers felt strongly that the Valley needs a new source of groundwater in order to meet it's future needs.
- Further conservation gains are necessary until new water resources are developed.

H. ORGANIZATION OF THE STUDY

This thesis consists of six chapters. Chapter II provides the reader with the historical background on the study area. Chapter III describes the major problems and issues facing Salinas Valley water users. Chapter IV discusses the survey methodology and presents the data that was obtained. Chapter V contains an analysis of the survey results in the aggregate, as well as, an analysis of several sub-category groupings based on size and geographic location. Chapter VI presents the conclusions and recommendations.

II. BACKGROUND

A. DESCRIPTION OF THE STUDY AREA

The area chosen for this research is the Salinas Valley, which consists of the lower portion of the Salinas River Drainage Basin. The Salinas Valley, occupying a structural depression parallel to the San Andreas Fault, includes most of Monterey and San Luis Obispo Counties. It is the largest intermontane valley in the California Coast Ranges. (Manning '63, p. 107) The valley is roughly wedge shaped and extends southeasterly from Monterey Bay to the highlands northwest of Bradley. It is 150 miles long and ranges from three miles wide at the upper southeastern end to around 15 miles wide at the lower northwestern end along the Pacific Ocean. The valley is bounded on the west by the Santa Lucia Range and the Sierra de Salinas and on the east by the Gabilan and Diablo Ranges. It has a fairly constant elevation gradient of 3.6 feet rise in elevation per mile as you move up the Valley. The Salinas Valley encompasses approximately 285,000 acres and overlies a single common aquifer of multiple depths. Figure 1.1 shows a map of the area. (Neagley '90, p. 7)

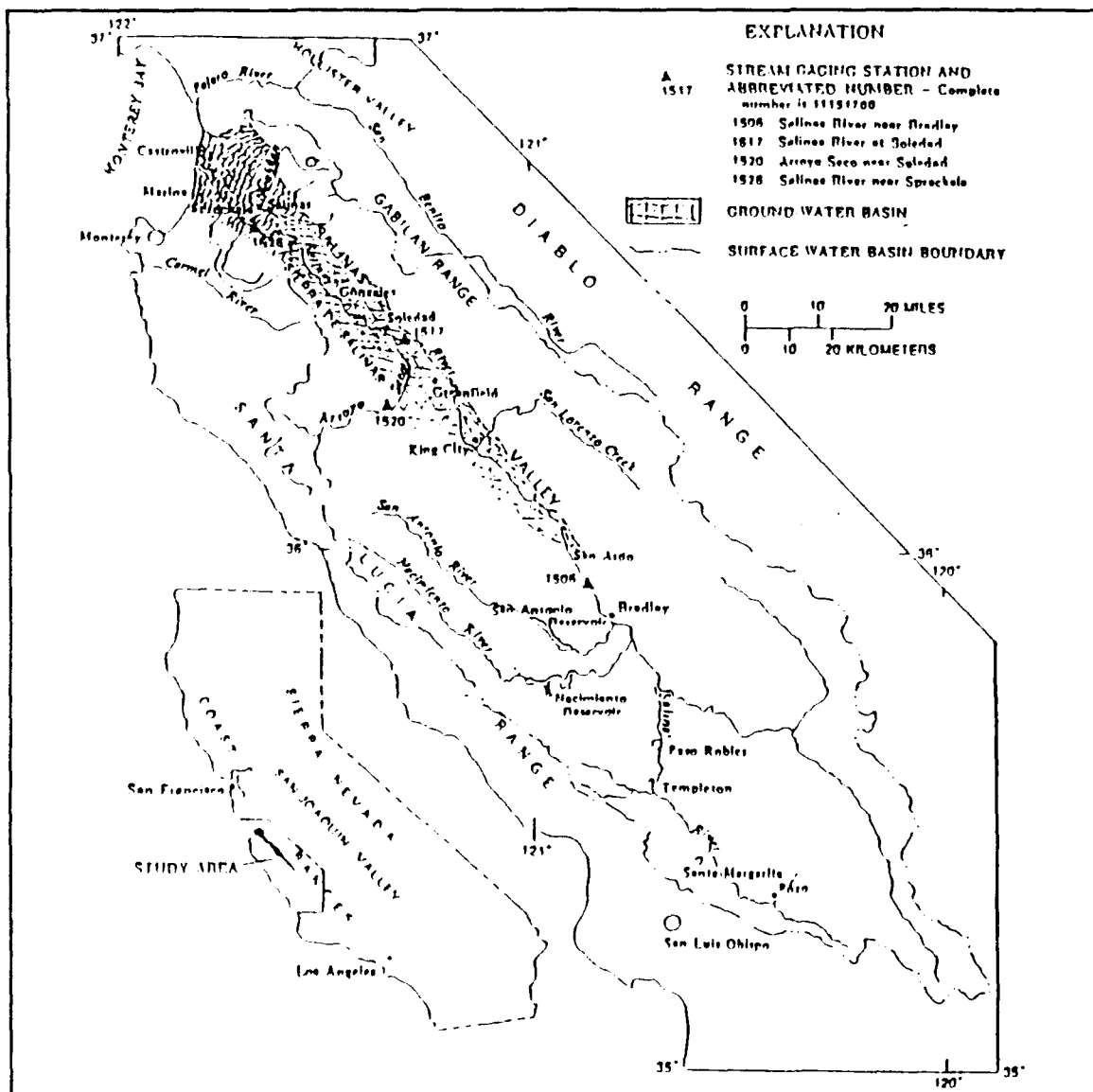


Figure 1.1 Monterey County and the Salinas Valley Aquifer

B. CLIMATE

The geographic location and topographic features of the Salinas Valley exert strong influences on the county's climate. The valley exhibits a Mediterranean climate that is characterized by year-round moderate temperatures with a short, cool winter rainy season and warm, dry summers. (MCFCWCD '90, p. 2-2)

The onshore winds and fog that are present most of the year exert a considerable moderating influence on temperatures throughout the county. This is reflected in relatively mild mean annual temperatures and the relatively small range between mean-maximum and mean-minimum temperatures. This influence decreases as one moves away from the coast and from north to south up the Salinas Valley. Therefore, temperatures in the upper valley are more extreme: generally colder in winter and warmer in summer. (MCFCWCD '90 p. 2-2) Proximity to the coast provides an additional benefit of milder winter temperatures and a longer frost free growing season.

Rainfall and its associated runoff recharge the groundwater reservoirs underlying the Salinas Valley. Precipitation, occurring almost entirely as rainfall, decreases from west to east across the Valley and varies from a maximum average of about 60 inches per year along the crest of the Santa Lucia Range to a minimum average of about nine inches at Soledad on the Valley Floor. Rainfall increases with elevation along the east side of the Valley and reaches

a maximum of about 20 inches per year along the crest of the Gabilan and Diablo Ranges. Most of the rainfall occurs during the winter months, from December to March. (Manning '63, p. 107)

The combination of topographic and climatic features, which characterize the Salinas Valley, have provided an ideal environment for a broad range of agricultural and ranching activities. As a result, the Salinas Valley has prospered from agricultural production.

C. HISTORY OF MONTEREY COUNTY AGRICULTURE

The establishment of the Spanish missions in what is now Monterey County in 1770 brought the first seeds of agriculture (DeMars '82, p. 3). As the mission fathers searched for ways to become self-sufficient, their most important development was the diversion of river water for irrigation (Anderson '89, p. 32).

In 1773 an aqueduct, paved with stones, was constructed from a 150-foot dam on the San Antonio river, about one-half mile upstream from the Mission. The aqueduct irrigated several thousand acres and the water also powered a grist mill. Thus, the first irrigation system in California was built and soon San Miguel and Soledad missions also constructed aqueducts. (Anderson '89, p. 32)

At least eight canals were constructed to divert water from local streams for irrigation purposes. Only one of these canals, one near Greenfield, is still being used. (Hansen '86, p. 1)

When the missions were secularized in the 1830s, nearly all of the mission lands passed into private hands. Branded cattle grazed the open valleys and foothills. Cattle hides and tallow replaced sea otter pelts as the prime trade commodity for the Monterey area. (Demars '82, p. 3)

In 1848, California became a territory of the United States. The discovery of gold in that same year brought a migration of fortune seekers to the area. With nearly everyone engaged in mining, food and other supplies had to come from distant places. (Allen '33, p. 5) All of these new arrivals created a growing market for beef and Salinas Valley ranchers were quick to respond. They began breeding beef cattle instead of the wild Spanish cattle valued only for hides and tallow. (Demars '82, p. 3)

The cattle and sheep industries remained dominant throughout the mid-1800's, due largely to the abundance of grasslands in Monterey County. Unfortunately, occasional floods and droughts took their toll and depleted the herds and flocks. The sheep industry no longer retains the prominence of those early years, but remnants of this industry have survived to this day. However, the development of modern beef cattle feedlot operations, with superior breeding and improved quality control, has resulted in more beef being raised today in the County than ever before. (DeMar '82, p. 3)

The shift from cattle-ranching to grain-farming is often attributed to the loss of cattle during the drought of 1862-

1864 (Allen '33, p. 13). However, it was not until the Southern Pacific Railroad was extended southward from San Francisco to Salinas in 1872 that grain production dominated the overall agricultural industry of the Salinas Valley (Allen '33, p. 16). It was discovered that wheat grew well in the more arid parts of the southern sections of the County. Later, barley was introduced and thrived in the southern half of the Salinas Valley. (DeMars '82, p. 3)

The advent of shallow well drilling in 1873, followed by deep well drilling capabilities, shifted emphasis within the Valley from canal construction and the use of riparian water to pumped water (Anderson '89, p. 29).²

Large-scale deep well drilling didn't really begin until about 1897 coinciding with the introduction of sugar beets. In 1889 there were only 891 acres under irrigation in the Salinas Valley and by 1899 there were 6675 acres irrigated. (Anderson '89, p. 29)

The dairy business began with C. S. Abbott in 1865 (Allen '33, p. 51). Swiss and Portuguese immigrants continued to expand the dairy industry, producing milk and cheese products. In 1883, the development of evaporated milk gave a tremendous boost to the county's dairy industry by eliminating the problem of spoilage. (Anderson '89, p. 31) The stock of dairy cattle was improved by introducing new breeds and the widespread use of alfalfa for feed. This industry thrived

²Riparian water refers to surface water which flows adjacent to a landowner's property, to which they have a certain legal right.

through the 1920s, but has not been a major part of the County economy since the 1940s. (DeMars '82, p.3)

Industry and prosperity arrived in the Salinas Valley in 1897 when Claus Spreckels built the world's largest beet-sugar refinery. Erected south of Salinas at a cost of \$2,700,000, this refinery employed five hundred people and consumed more than 3,500 tons of beets per day. Thousands of acres were devoted to growing sugar beets and the monetary returns were fantastic. (DeMars '82, p. 4) After nearly 85 years of operation, the refinery closed in 1982 because of increased international competition. The demise of sugar beets as the Valley's leading cash crop lead to the development of irrigated row crops.

Orchards of apples, pears, apricots, and nuts were planted in the Pajaro Valley, the Carmel Valley, and in the vicinity of Greenfield, Arroyo Seco, and King City in the Salinas Valley in the early 20th century (DeMars '82, p. 4). Potatoes had been a minor crop in Monterey County from the gold rush days, but production increased dramatically with the introduction of irrigation (Anderson '89, p. 31).

Development of powerful new turbine pumps after World War I enabled farmers to develop groundwater based irrigation systems. This would alter the course of all future agricultural development in the County (DeMars '82, p. 4). This technological development was the most significant single force in shaping the future of agricultural development in the

Salinas Valley and helped precipitate the current water management problems. For now, the door had been opened to the possibility of growing vegetables and other crops requiring intensive irrigation, greatly increasing the demand for water resources in the Valley (DeMars 82, p. 4).

The period between World War I and the end of World War II was marked by dramatic changes in the Monterey County agricultural scene; the major changes being the switch from horsepower to internal combustion engine power, the rise of the lettuce business, the beginnings of the artichoke industry, strawberry plantings, introduction of other vegetable crops, and the production of guayule rubber. (Anderson '89, p. 40)

The Guayule rubber plant was introduced into the United States in 1912. By 1932, 6000 acres were ready for harvest in Monterey County. As a result, the American Rubber Co. built a plant in the upper Salinas Valley. (Anderson '89, p. 46) Government support was sought to expand this industry. Such assistance was not provided, however. Opposition from the synthetic rubber interests of the large petroleum companies was blamed for obstructing the full development of this industry. (DeMars '82, p. 4)

Mose S. Hutchings grew the first lettuce on the central coast in the Pajaro Valley in 1916 (Anderson '89, p. 40). By 1922, several other Salinas Valley farmers had begun raising iceberg lettuce, tomatoes and other row crops. These crops required extensive irrigation. These vegetables soon replaced sugar beets and beans as the County's leading crops. (Demars '82, p. 4)

The most significant event in Salinas Valley agriculture after the World War II era was the development of vacuum cooling in the early 50's. It enabled lettuce to be cooled without the use of ice. Also, the use of the vacuum cooler and liner-board cartons enabled shippers to pack in the fields, eliminating the manpower required in the traditional packing shed. This enabled many newcomers to enter the lettuce shipping business. (Anderson '90, p. 38)

Sprinkler irrigation became dominant after WWII, since crops could be germinated faster and with less water than was possible by the old subbing (furrow) method. ...Sprinkler irrigation also allowed unlevel and hilly ground to be watered, thereby expanding vegetable crops into previously dry land farming areas... (Anderson '90, p. 39)

The 1970's and early 80's saw rapid acreage increases in broccoli, cauliflower, grapes, and nursery crops. Another trend was the decline in the acreages of such crops as sugar beets and dry beans. These latter crops have had difficulty in competing because of their relatively lower profits when compared to vegetables. (Ririe '83, p. 6)

Diversification and experimentation in agriculture since World War II has kept Monterey County very competitive in a wide range of agricultural products. Combinations of unusual micro-climates and excellent soils explain the diversity of crops grown here today. Artichokes, strawberries, and grapes have thrived in very specific areas of the County. Development of local floriculture, indoor production of mushrooms, and innovations in other agricultural crops and

processes have also contributed to the County's evolution in this industry. (DeMars '82, p. 3)

D. AGRICULTURAL PRODUCTION

Through aggressiveness and innovation, the agricultural industry of Monterey County has enjoyed great success at maintaining its competitive advantage. The combination of soils, water, climate and a long growing season create particularly good conditions for a wide variety of crops. (DeMars '82, p. 1) As a result, Monterey County is the nation's leading vegetable-producing county, with annual revenues exceeding one billion dollars (MCAC '90, p. 1). There are now over 40 agricultural commodities in Monterey County which currently show a gross revenue of over a million dollars. (MCAC '91, p. 26)

As of 1990, Monterey County produced crops worth 1.39 billion dollars, of which 67.8 percent were vegetable crops (MCAC '91, p. 34). The mix of crop acreage has shifted dramatically over the course of the last three decades. Vegetable acreage has risen dramatically during this period, partially due to double or triple-cropping.³

In terms of gross revenue, head lettuce was the Valley's leading crop for 1990, followed by strawberries, broccoli, nursery crops, leaf lettuce, cauliflower, grapes, celery,

³The practice of growing multiple crops at one site in a single production year.

mushrooms, and cattle (MCAC '91, p. 33). Trends in acreage planted and annual values of major crops in Monterey County are shown in Table 2.1. (Lemoine '84 p.44) (MCAC '91, p. 7-13)

TABLE 2.1 MAJOR CROPS IN MONTEREY COUNTY: 1981 AND 1990

	ACRES		VALUE (\$1,000)	
	1981	1990	1981	1990
LETTUCE	67,540	58,280	264,914	325,019
BROCCOLI	41,390	48,700	90,567	129,195
STRAWBERRIES	2,560	5,830	48,570	181,459
CAULIFLOWER	18,870	22,340	53,736	85,115
GRAPES	27,950	25,248	49,628	63,719
CELERY	6,200	7,290	34,990	53,346
TOMATOES	7,280	7,770	24,829	28,471
ARTICHOKES	8,260	6,970	36,510	23,147
CARROTS	5,090	3,180	16,870	11,401
PEPPERS	3,510	3,870	7,361	13,976
ONIONS	1,420	1,020	11,490	10,498
SUGAR BEETS	16,750	2,740	18,549	4,223
POTATOES	1,870	1,000	3,805	2,700
DRY BEANS	6,300	1,570	5,905	2,656
ALFALFA	9,000	2,970	5,355	1,903
BARLEY	51,000	12,780	7,650	1,254
TOTAL	276,630	211,558	690,483	938,082

1. Note: All figures represent gross revenues and account for multiple cropping. Additionally, the 24% decrease in acreage for 1990 may be explained by an ongoing federal soil conservation program coupled with the effects of the drought on dryland farming.

As a result of the shift to vegetable crops, the demand for a manual labor work force has risen. It is not surprising

that a large portion of the total work force of the Salinas Valley is directly involved with agricultural production. Therefore, agriculture is vital to the livelihood of a majority of Valley residents.

The agricultural industry has enjoyed an increase in profitability over the last three decades. In spite of the recent drought, new records for production have been set. However, the development of additional irrigable land over time, coupled with the agricultural management practices of double or triple cropping, have taken a toll on the Valley's underground water reserves. Escalating production costs and higher pumping costs are affecting profit margins. Further production gains are not likely due to a proposed water related moratorium on further agricultural land development within the Valley. There are only about 6000 acres of undeveloped irrigable land left within the Salinas Valley (Mills '91, p. 1).

Irrigation needs throughout the Valley vary considerably, not only because of crop requirements, soil type, and rainfall variations, but also because of the amount of moisture present in a location. The areas closer to the coast have less evapotranspiration from plants and soil because of low clouds and fog, particularly in the summer (DeMars '82, p. 12).⁴

⁴evapotranspiration is the process of moisture loss to the atmosphere by living plants and soil.

Table 2.2 shows the approximate water consumption by crop type in the Salinas Valley. (Lemoine '84, p. 47)

TABLE 2.2 WATER CONSUMPTION BY CROPS

Name of Crop	Ave Acre-feet/ Month/Acre of Crop	Growing Season
LETTUCE	2.5	All year
BROCCOLI	2.0	All year
CAULIFLOWER	2.5	All year
ARTICHOKES	1.75	All year
CELERY	3.5	All year
TOMATOES	2.75	March-October
CARROTS	2.75	All year
POTATOES	2.5	April-November
SUGAR BEETS	3.5	All year
WHITE BEANS	2.5	May-October
ALFALFA	3.0	All year
GRAPES	1.5	March-November
STRAWBERRIES	5.0	All year

E. WATER RESOURCES

The Salinas River Basin is the source of groundwater resources for the Salinas Valley. The Salinas River is the largest subterranean river in America and supplies a natural underground water storage and distribution system for Salinas Valley farmers (Lemoine '84, p. 46). It encompasses an area of 4,458 square miles, and includes parts of Monterey, San Luis Obispo and San Benito Counties. The hydrologic aquifer

beneath the Salinas Valley contains water-bearing sediments up to 3,000 feet deep in places (MCFCWCD '90, p.2-3).

The Salinas River flows directly over the groundwater basin and is the primary source of recharge for this underground reservoir. Practically all irrigation water used in the Valley is pumped from wells tapped into the Salinas aquifer. Rapid surface absorption of the river's water replenishes the large aquifer layers in the valley. Large quantities of water can be pumped from the aquifer, even during droughts, by drawing on the existing reserve capacity. The reserve capacity is estimated to be between one and ten million acre-feet of useable groundwater (Mills '91, p. 1).

As much as 90 percent of the area's rainfall occurs during the six-month period from November to April (Lemoine '84 p. 46). Stream flow is greatly reduced thereafter. Two water storage reservoirs were constructed by the County in 1956 and 1965. These reservoirs provide a reserve capacity for the dry months and flood control during the rainy months. Both the Nacimiento and San Antonio reservoirs were designed to hold 350,000 acre feet of water.⁵ (Bunte '74 p.2) Controlled releases from these two reservoirs provide substantial aquifer recharge throughout the summer. Releases from the reservoirs are controlled to maximize the amount of percolation benefit

⁵An acre-foot is equal to approximately 333,333 gallons.

to the aquifer while minimizing losses to the Pacific Ocean.⁶ Maximizing the yield of groundwater from percolated surface water requires that surface water be controlled so that it flows above the aquifer at a rate as close as possible to the percolation rate (Neagley '90, p.21.).

The Salinas Valley groundwater basin is a single hydrologic unit without divisions. However, it has commonly been divided into four subareas for purposes of analysis: Pressure; Eastside; Forebay; and Upper Valley. Figure 2.1 depicts the hydrologic areas of the Salinas Valley (Neagley '90, p.22).

1. Upper Valley Area

The Upper Valley Area extends from about six miles north of Bradley to about 7.5 miles north of King City. Major urban areas are San Ardo, San Lucas, and King City. Sargent, Pine, San Lorenzo, and Pancho Rico Creeks originate in the Diablo Mountains and feed the Salinas River. The Nacimiento and San Antonio Rivers, which originate in the Santa Lucia Mountains, join the Salinas River less than two miles south of Bradley. (MCFCWCD '90, p. 2-3)

2. Forebay Area

The Forebay Area extends from the northern boundary of the upper Valley Area to about the city of Gonzales. The major

⁶Percolation is the process whereby water is absorbed down into the aquifer layers at a finite rate dependent upon the composition of the overlying stream bed.

urban areas in the Forebay Area are Greenfield and Soledad. The only tributary of significance from the east side is Chalone Creek. Included in this area is the Arroyo Seco Cone, which is generally the area formed by the fan of Arroyo Seco and Reliz Creek. Both of these streams originate in the Santa Lucia Mountains west of the Forebay Area. (MCFCWCD '90, p. 2-4)

3. Pressure Area

The Pressure Area extends from Gonzales to Monterey Bay and lies west of Highway 101. Major urban areas are Gonzales, Chular, Salinas, and Castroville. The only major tributary to the Salinas River in this area is El Toro Creek which originates in the Santa Lucia Mountains. Three horizontal layers of the groundwater aquifer are recognized in this area. They are the "180-foot aquifer layer," the "400-foot aquifer layer," and the "900-foot aquifer layer." (MCFCWCD '90, p. 2-4)

4. East Side Area

The East Side Area extends from Gonzales, north to about three miles east of Castroville and lies generally east of Highway 101. Major urban areas are Santa Rita and eastern suburban areas of Salinas. Tributaries to the Salinas River in this area are Chular, Quail, Alisal, Natividad, and Gabilan Creeks, all of which originate in the Gabilan Mountains. (MCFCWCD '90, p. 2-4)

The map displays a cross-section of the Upper Valley area, with various geological units and hydrologic boundaries. The units are labeled as follows:

- Albion and Royal Gorge** (including the Fort Benton Formation of Madison, Permian and Frontier 191)
- Woodworth** (including the Madison and Permian 191)
- Frontier** (including the Madison 191)
- Permian** (including the Madison 191)
- Triassic** (including the Madison 191)
- Quaternary** (including the Madison 191)
- Contour** (including the Madison 191)

The hydrologic boundaries are indicated by dashed lines, and the ground water basin boundary is shown by a solid line. The map also includes a scale bar in miles (0 to 10) and kilometers (0 to 16).

25

III. PROBLEMS AND ISSUES

The aggressiveness and innovation of the agricultural industry, which has been the predominate source of prosperity for the Salinas Valley, has also been the main focus of escalating water management problems and issues. The historical development of additional irrigable land, increased acreages planted in vegetable crops, and the management practice of double or triple cropping, have been the principle contributors to stress on existing water supplies.

The paramount water problem facing the Salinas Valley is that the demand for groundwater resources from municipal, industrial and agricultural water users has outpaced supply. In the Salinas Valley, groundwater remains the only source of water supply for all user groups. It is necessary to correct the imbalance between demand and available water resources to sustain the long term economic growth of this vibrant valley, whose crops are of national importance.

Although economic development has increased water demand from all segments of the community, the share of groundwater used for irrigation pumping has remained at approximately 90 percent of the water used (Lemoine '84, p. 52). Since the agricultural industry is by far the largest water user group in the Valley, they are key to the successful resolution of water management problems and issues. Therefore, the future

of the Salinas Valley will depend primarily on identifying and understanding the problems and issues of water resources management at the individual grower level. This chapter will identify some of the major water resource problems and issues facing the Salinas Valley.

A. CORRELATIVE RIGHTS DOCTRINE

In 1903, the State of California adopted a groundwater use doctrine known as the "Correlative Rights Doctrine." Under this law, overlying landowners have coequal rights to the groundwater beneath their properties, with the following provisions:

First, in the event that the demand for groundwater exceeds the supply, then all overlying landowners must reduce their use on a coequal basis. Second, in cases where supplies are in excess of the reasonable needs of overlying landowners, then water may be put to use in areas that don't overly the aquifer itself (Anderson '83, p. 228)

The "Correlative Rights Doctrine" has a very serious shortcoming in situations where demand for water exceeds supply. It is difficult to enforce coequal reduction in the overlying landowners' water use without some reasonable means of determining each individual's current water use. This doctrine also requires some form of government action to enforce the property rights established in the law. Clearly, the "Correlative Rights Doctrine" provides a "use or lose" mentality and landowners have little incentive to conserve groundwater resources. If they do not pump the water, someone

else will. Since there is no charge for the groundwater itself, the cost of water is a function of the pumping cost and pumpers clearly anticipate that the pumping cost will increase in the future. (Neagley '90, p. 51)

B. COMMON RESOURCE PROBLEM

Groundwater is a "common pool resource" in that there is no restriction on its access (Stiglitz '86, p. 179).⁷ Any individual landowner can drill a well and pump as much water as desired. In fact, there are incentives for individual landowners to use all they can today before it becomes more expensive to pump in the future. The result is a growing "negative externality."⁸ The costs to society from damage and depletion of the aquifer are not being reflected in the decisions of individual pumpers. The calculation of benefits and costs by individual pumpers fails to reflect the total impact of their pumping on society and a social misallocation of resources results (Neagley '90, p. 11). The existing federal, state and local laws fail to include all of the significant consequences of decisions by individual pumpers.

⁷A common pool resource is a pool of scarce resources to which access is not restricted. An example would be a pool of oil in a commonly shared oil field.

⁸Externalities are the side effects of an action that influence the well-being of nonconsenting parties. The nonconsenting parties may be either helped (positive externality) or harmed (negative externality).

C. OVERDRAFT OF THE AQUIFER

For most of the last two decades, Salinas Valley water users have "overdrafted" the underlying aquifer's finite water reserves.⁹ They have pumped more water out of the aquifer than the natural and augmented recharge efforts could replenish. When "overdrafting" occurs in a coastal region, the void created within the aquifer by excessive freshwater extraction will be filled by seawater, through the phenomenon known as "seawater intrusion."¹⁰

Groundwater levels have been declining in all four of the sub-units of the Salinas Valley hydrologic unit, also referred to as the Salinas Valley Groundwater Basin (SVGB). Groundwater consumption rates have resulted in a negative groundwater balance in 14 of the last 20 years. In 1990, the Valley's water users pumped a record 300,000 acre-feet of "overdrafted" groundwater. It is also important to note that "seawater intrusion" (SWI) can occur even during years of positive groundwater balances if the underlying aquifer is still experiencing a net negative groundwater balance. Figure 3.1 dramatizes the degree of the "overdraft" problem during

⁹ Overdrafting is the process of pumping more groundwater from an aquifer than is being returned through natural and supplemental processes.

¹⁰ Seawater intrusion is the process of infiltration of seawater into the groundwater aquifer layers as a result of a negative pressure gradient, caused by lowering the aquifer's water table to below sea level through excessive above ground pumping.

the last 20 years and highlights the recent increase in the amount of "seawater intrusion." (Win '91, p. 6)

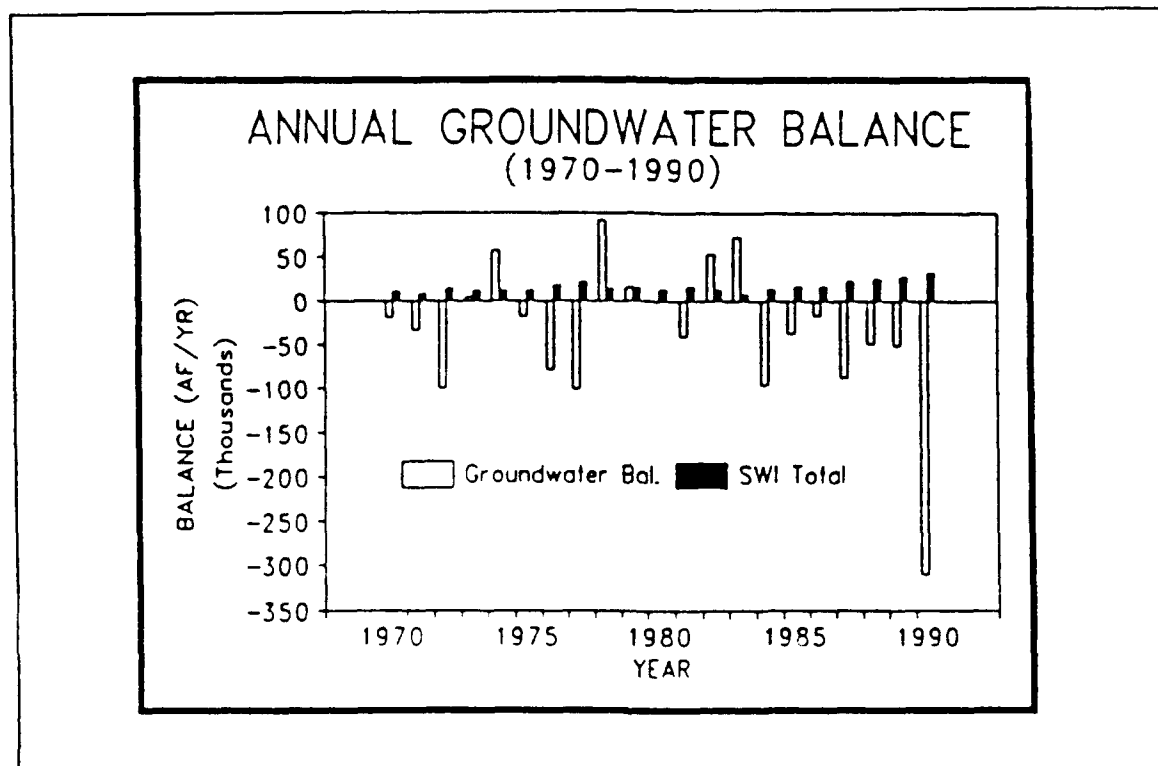


Figure 3.1 Annual Groundwater Balance

The Salinas Valley Groundwater Basin experiences an annual average "overdraft" of 45,000 acre-feet, which causes 15,000 to 17,000 acre-feet of "seawater intrusion." Historically, this "overdrafting" has caused seawater in the Pressure Area's 180' aquifer to move southeastward at the rate of 0.25 miles/five years. However, five consecutive years of below average rainfall in the SVGB and watersheds has resulted in an approximate total "overdraft" figure of 600,000 acre-feet.

This has increased the rate of seawater intrusion to 0.75 miles/five years. (Mills '91, p. 1)

The tremendous "overdraft" deficit of the last five years has had a geographically disproportionate affect on groundwater levels in the Salinas Valley Groundwater Basin. This is due to the fact that the hydrologic subunits transmit water at differing rates, depending on the aquifer characteristics determined by the geologic depositions within the subunits. The current recharge benefit from percolation of released reservoir water has a greater effect on stabilizing the groundwater levels in the upper end of the Salinas Valley than in the lower end of the Valley. (Mills '91, p. 1)

The northeastern section of the Valley has experienced the greatest decline in groundwater levels in the past five years. The benchlands of the Forebay and Upper Valley areas have experienced the most significant declines in pumping levels. In contrast, the bottom land areas from Gonzales to San Ardo, and particularly the Arroyo Seco cone and Mission area near Soledad, have experienced very limited supply degradation. The problem which results is that the water supply benefits are not equally distributed within the groundwater basin. (Mills '91, p. 1)

Another problem concerns the issue of voluntary conservation. "Overdraft" is a public good in that it affects

everyone in the area (Rhoads '85, p.66).¹¹ Expecting voluntary conservation of any public good is a highly unlikely prospect.

Each pumper would benefit from the voluntary conservation efforts of his neighbors, regardless of whether he saves water himself. Thus, he has less incentive to voluntarily conserve groundwater. This is referred to as the "Free Rider" problem (Stiglitz '86, p. 100).¹² The benefits of reducing the "overdraft" problem via efforts like the County's Agricultural Water Conservation Program are distributed over a large population. Thus, each pumper's benefit is small relative to the total benefit to society. However, the costs of conserving are large relative to each pumper's individual benefit. As a result, pumpers are not likely to voluntarily cut back on their water usage. (This behavior was clearly observed at a Fall, 1991 meeting of the Monterey County Agricultural Water Conservation Task Force. Over half of the members present jokingly acknowledged their failure to comply with their own Agricultural Water Conservation Plans.) In short, voluntary conservation isn't likely to work, unless government mandated conservation programs are considered less

¹¹Public goods are goods that are simultaneously consumed (or shared) by a large group of people and where it is prohibitively expensive or impossible to confine the benefits (or cost) of the good to selected individuals.

¹²Free Riding refers to the reluctance of individuals to contribute voluntarily to the support of public goods.

desirable than voluntary efforts and the threat of government enforcement is perceived to be a real threat.

It is clear that continued "overdrafting" threatens the economic and environmental future of the Salinas Valley. Some of the effects include increasing pumping cost, diminished groundwater availability and "seawater intrusion."

D. SEAWATER INTRUSION

Despite the increased groundwater resupply provided by the Valley's two existing reservoirs, groundwater pumping continues to exceed the total recharge capabilities for the aquifer. Pumping in excess of replenishment has gradually lowered groundwater tables and decreased the pressure gradient in the coastal portion of the aquifer. The decreased pressure gradient has resulted in "seawater intrusion" in the 180 and 400 foot aquifer layers. (DeMars '82, p. 9) This has resulted in a number of problems including:

- Salt-water contamination of some wells near the coast.
- An increasing annual loss of irrigated farm land near the coast because uncontaminated water supplies are not available.
- The mounting cost of drilling deeper wells to reach the uncontaminated groundwater in the 900 foot aquifer in the Pressure Area.
- The increased cost of pumping from greater depths.
- The potential economic disaster of having the seawater intrusion front reach municipal water wells in the lower Valley.

- The potentially irreversible environmental damage to the aquifer, due to lost fresh groundwater reserve capacity.

The major issues associated with the problem of "seawater intrusion" are the determination of who is ultimately responsible for the problem and who should pay for rectifying the associated problems created by this phenomenon. Similarly at issue is whether the entire Salinas Valley considers "seawater intrusion" as a mutual problem. Users outside the Pressure Area may believe that it is a local problem confined to the Pressure Area, one which doesn't affect their individual pumping decisions.

E. ECONOMIC PROBLEMS AND ISSUES

The MCWRA provides recharge of the Salinas Valley aquifer by releasing water from the Nacimiento and San Antonio reservoirs into the Salinas River. The dams are operated for the benefit of the property owners in Zones 2 and 2A of the Monterey County Flood Control and Water Conservation District. These two zones encompass a major portion of the valley floor that can be irrigated, as shown in Figure 3.2. The "standby" or "availability" charges levied on the land owners in Zones 2 and 2A are assessed on the property tax bill, based on the type of land use rather than on consumptive use. Therefore, these rates do not alter consumer behavior with regard to consumption because they provide no economic incentive to the users to reduce consumption. (Neagley '90, p. 41)

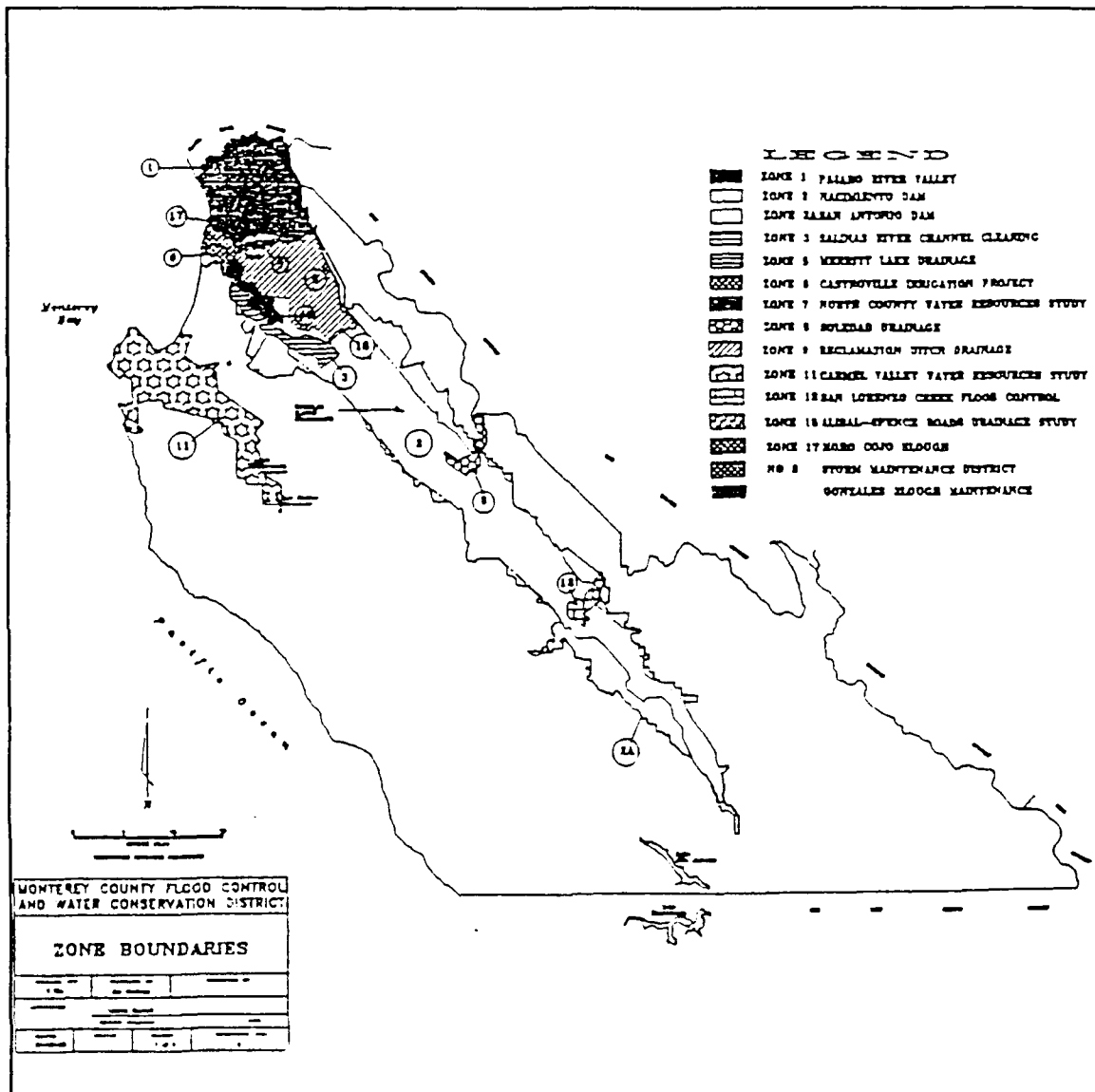


Figure 3.2 Zones of the Monterey County Flood Control and Water Conservation District

An additional economic problem involves the equity of the distribution of benefits from the two reservoirs used to recharge the aquifer. All irrigated farm land in the Salinas

Valley's Zones 2 & 2A are assessed a flat per acre rate, based on land type, for flood control and aquifer replenishment benefits. The physical and geographic characteristics of the Salinas Valley Groundwater Basin create inequities in the level of benefit received for the same assessment. (Mills '91, p. 2) Those growers who are most affected by "seawater intrusion" receive the least groundwater level stabilization benefit from the aquifer recharge releases. However, they pay the same per acre assessment for water as other growers with similar land types who are receiving greater benefit.

Another economic problem is that water appears to be underpriced. The current "standby" assessments do not include the marginal cost of developing additional water resources to provide for current and future demand. Additionally, this price does not reflect the "negative externalities" borne by society due to the decisions made by individual pumpers. At the present time, the "standby" assessments and pumping costs constitute the average price borne by the user for his water supply.

A mandatory set-aside program has been suggested as one potential means of achieving agricultural water conservation. However, a program of this type, requiring coequal set-asides, would have a disproportionate economic impact on individual growers. Per acre land values range from about \$200 to \$1800 dollars depending on location (Mills '91, p. 2). Additionally, individual growers may not be able to withstand

the reduction of income from such a program. Conversely, a larger question can be raised as to whether the Salinas Valley will be able to continue it's national dominance in vegetable production into the future without some immediate and real conservation of it's existing groundwater resources.

Another economic problem arising from the current situation is that there are no incentives at the individual grower level to promote measurable conservation of groundwater under the current Agricultural Water Conservation Program. The current program lacks any positive incentives and presents only a minimal threat of enforcement to individual growers. Neagley and O'Brien explored the possibility of some form of taxes or subsidies to promote more efficient use of agricultural water. (Neagley '90, p. 62)

As water well metering becomes required by law next year, a number of questions arise including:

- Who should bear the cost of installation?
- Will the installation require a nitrate backflow shutoff valve?
- Will the meters be used as a means of determining individual water use for the purpose of taxation?
- Will metering cause inflated water usage in the short run?

F. INSTITUTIONAL PROBLEMS

A major institutional problem in complying with current California State Law is that the Monterey County Water

Resources Agency, which is responsible for groundwater management, lacks the quantitative pumping data to use in enforcement of coequal reductions of groundwater use by individual pumpers. Also, the Monterey County Water Resources Agency presently lacks the manpower necessary to implement, administer, and enforce a mandatory water conservation program. (Mills '91, p. 2) Additionally, there are the problems arising from the coordination of water management responsibilities among the extremely diverse collection of governmental and private water interest groups and organizations in the Valley. Finally, there is the issue of acceptance of government involvement in water matters, which some growers and ranchers feel are their individual concerns only.

IV. METHODOLOGY AND DATA

A. METHODOLOGY

The data presented in this chapter were gathered by conducting a mail survey of the total population of growers and ranchers in the Salinas Valley Groundwater Basin. The target population was derived from the data base of mandatory Agricultural Water Conservation Plans submitted to the Monterey County Water Resources Agency in 1991.

The survey population consisted of 259 potential respondents covering a spectrum from small individual farm operations, to multiple farm operations under a single corporate manager. Nine of the potential survey respondents had operations in the Salinas Valley, but had headquarters addresses in cities outside of the Valley. These nine were excluded from the survey due to the a lack of sufficient data needed to determine the geographic location of their operations within the Salinas Valley. There were four survey packets returned due to lack of a current address for the potential respondent. Therefore, 246 survey packets were received by potential respondents. Of these, 52 responses were received by the survey close-out date. This represented a response rate of 21% of the total population. (22% counting the surveys returned after the close-out date.)

1. SURVEY DESIGN

In constructing the survey, the first question that had to be answered was; "Why do people respond to any survey?" This question is specifically addressed by Mr. Donald Dillman in his book "Mail And Telephone Surveys: The Total Design Method."

The 'Total Design Method' (TDM) assumes that people engage in an activity because of the rewards they hope to reap, that all activities they perform incur certain costs, and that people attempt to keep their costs below the rewards they expect to receive. Fundamentally then, whether a given behavior occurs is a function of the ratio between the perceived costs of doing that activity and the rewards one expects the other party to provide at a later time. (Dillman '78, p. 12)

Thus, there are three things that must be done to maximize survey response: minimize the costs for responding, maximize the rewards for doing so, and establish trust that those rewards will be delivered. (Dillman '78, p. 12) Mr. Dillman suggests the following things to encourage response:

1. Reward the respondent by:

- showing positive regard.
- giving verbal appreciation.
- using a consulting approach.
- supporting his or her values.
- offering tangible rewards.
- making the questionnaire interesting.

2. Reduce costs to the respondent by:

- making the task appear brief.
- reducing the physical and mental effort required.
- eliminating chances for embarrassment.
- eliminating any implication of subordination.
- eliminating any direct monetary cost.

3. Establish trust by:

- providing a token of appreciation in advance.
- identifying with a known organization.
- building on other exchange relationships. (Dillman '78, p. 12)

The survey cover letter and questions were modeled after the TDM approach. Each of the three major TDM areas were addressed in detail. Every effort was made to incorporate as many aspects of TDM as possible.

The cover letter and survey incorporated a number of rewards to the potential respondent by stressing that the knowledge learned is useful and including:

- a pitch for equal representation from all locations.
- a request to...let your views be made known...
- a promise to distribute the results to the relevant government organizations.
- a personal thanks.
- a real signature by the researcher.
- an individual salutation.
- a stated desire for the grower's input.

- an invitation for additional comments.
- a supportive attitude toward the grower's values.

The cover letter and survey were constructed to minimize the costs to the potential respondent by:

- designing the majority of the survey for quick responses.
- making the survey appear easy to complete.
- eliminating overly direct questions.
- saving longer questions for last.
- giving an option for not completing all questions.
- providing a fully self-addressed, stamped, return envelope.

The cover letter and survey both used numerous opportunities to build the trust of the potential respondent by:

- building trust by appealing for any additional inputs or comments.
- guaranteeing anonymity.
- providing a stamped envelop as a gesture of sincerity.
- identifying with the target group as a farm owner.
- establishing trustworthiness as an officer and independent party.
- stressing a sincere desire to learn from the respondent.
- maintaining independence of perspective.
- building trust by eliminating any appearance of subordination.

The survey underwent six different drafts before being distributed. Inputs were solicited from members of the Agricultural Industry, Monterey County Farm Bureau, Monterey County Water Resources Agency, Salinas Valley Water Advisory Commission, and Naval Postgraduate School faculty. Several pilot surveys were constructed and used to further refine the final product.

The final survey consisted of 27 questions. The first five questions asked for demographic data on the target population. Question six established any interest group affiliations. Question seven established the respondent's type of operation. Questions 8 - 20 were designed to test for respondent's knowledge of current water problems and to provide data on the existence and strength of barriers to solving the problem. Questions 21 - 27 specifically addressed the physical, economic, social, and political constraints to more effective water management, along with other supplemental questions. Appendix A contains a copy of the survey.

B. DATA

The aggregate survey results will be presented by listing each question in the order in which it was asked, with the totals for each type of response displayed adjacent to that question. For question ten, each respondent's number one ranked answer was used to arrive at the aggregate totals. The answers for questions 21 - 27 are ranked by frequency of

(similar) response, and presented in descending order of occurrence.

AGGREGATE TOTAL SURVEY RESPONSES

AGRICULTURAL WATER MANAGEMENT SURVEY

1. 51 Male
1 Female
2. Age: (2) 20-29 years old, (16) 30-39 years old, (17) 40-49 years old, (7) 50-59 years old, (8) 60-69 years old, (1) 70-79 years old, and (1) no answer
3. Ethnic background: 37-Caucasian, 2-German, 3-Italian, 1-Mexican, 2-European, 2-Japanese-American, 1-Japanese, 1-Swiss, 1-Danish, and 2-no answer
4. Highest level of education completed: (please mark only one response)

0 Grammar school level
13 High school level
32 B.S./B.A.
5 M.S./M.A.
1 Ph.D.
1 No answer
5. Political party affiliation: (please mark only one response)

7 Democratic party
35 Republican party
10 Other: 1-Libertarian, 7-Non Affiliated,
1-Independent, 1-Non-U.S. Citizen

AGGREGATE TOTAL SURVEY RESPONSES

6. Please mark the agricultural and/or water interest groups you belong to: (please mark those responses that apply)

31 Monterey County Farm Bureau
21 Grower Shipper Vegetable Association
10 Salinas Valley Water Advisory Commission
8 M.C. Agricultural Water Conservation Task Force
14 Salinas Valley Water Coalition
11 Other 2-Grape Grower's Assn., 1-M.C. Cattleman's Assn., 1-Irrigation Assn., 1-Iceberg Lettuce Research, 2-Western Grower's Assn., 1-CA. Assn of Family Farmers, 1-Backflow Commission, 1-Nitrate Commission, 1-M.C. Agricultural Education Commission

7. With regard to this farm, I am: (please mark only one response)

12 Owner and sole proprietor
7 Tenant farmer
12 Farm manager for a corporate enterprise
2 Farm manager for a non-corporate partnership
16 Both own and lease farmland
3 Other: 1-Field Researcher, 1-General Partner, 1-Research Director for a seed company

8. I believe that the Salinas Valley groundwater basin is served by: (please mark only one response)

21 A single common aquifer of varying depths
30 Unique isolated aquifers in various locations
0 Underground springs that are the source of groundwater
1 Other: 1-All of the above

9. The major cause of the valley's seawater intrusion is: (please mark only one response)

12 Excessive pumping by coastal growers
36 Valley-wide overdrafting of the underground aquifer
2 A change to water intensive crops valley-wide
0 Seawater intrusion isn't a serious problem
0 A change to water intensive crops by coastal growers
2 Other: 1-Ag plus Urban Overuse, 1-Drought

AGGREGATE TOTAL SURVEY RESPONSES

10. I stay informed on water management issues by: (indicate and rank all those that apply, beginning with 1 for the most used)

16	Newspaper	(ranking)	_____
4	"Coffee shop" conversations	(ranking)	_____
0	TV news programs	(ranking)	_____
0	Radio	(ranking)	_____
3	Magazines	(ranking)	_____
5	Newsletters	(ranking)	_____
18	Attendance at public meetings	(ranking)	_____
6	Other:	(ranking)	_____
	2-MCWRA contacts, 1-Direct contact with growers,		
	2-No answer, 1-Farm Bureau contact		

11. We are in danger of depleting the groundwater reserves in the valley as we end this fifth year of drought. (please mark only one response)

14 Strongly agree
 16 Agree
 3 No opinion
 18 Disagree
 1 Strongly disagree

12. I observe that my neighboring growers are very diligent in their daily water management. (please mark only one response)

5 Strongly agree
 19 Agree
 15 No opinion
 11 Disagree
 2 Strongly disagree

13. The water requirements for a given crop type significantly enter into my decision making when I am choosing my crop mix. (please mark only one response)

9 Strongly agree
 11 Agree
 9 No opinion
 15 Disagree
 8 Strongly disagree

AGGREGATE TOTAL SURVEY RESPONSES

14. The agricultural community in the Salinas Valley has the cohesiveness to resolve the current water problems on it's own. (please mark only one response)

9 Strongly agree
14 Agree
2 No opinion
18 Disagree
9 Strongly disagree

15. I consider pumped water a common resource, in that each grower's use has a direct impact on other growers. (please mark only one response)

22 Strongly agree
24 Agree
1 No opinion
5 Disagree
0 Strongly disagree

16. I believe that a mandatory acreage set-aside program is the best water saving alternative for ensuring that an equal conservation burden is shared by all growers. (please mark only one response)

8 Strongly agree
10 Agree
1 No opinion
18 Disagree
15 Strongly disagree

17. I am in favor of metering wells as a means of monitoring individual water use for the purpose of allocating groundwater resources. (please mark only one response)

10 Strongly agree
8 Agree
3 No opinion
15 Disagree
16 Strongly disagree

AGGREGATE TOTAL SURVEY RESPONSES

18. Most growers that I know attempt to conserve groundwater, so that they will have sufficient groundwater levels 20-30 years from now. (please mark only one response)

9 Strongly agree
19 Agree
5 No opinion
17 Disagree
2 Strongly disagree

19. I feel there is a need to formulate a long term water management plan for the Salinas Valley. (please mark only one response)

37 Strongly agree
10 Agree
1 No opinion
2 Disagree
2 Strongly disagree

20. Who do you feel should take the leadership role in management of water resources in the Salinas Valley? (please mark only one response)

12 Monterey County Water Resources Agency
1 County Board of Supervisors
13 Board of Directors of the Monterey County Water Resources Agency
0 State Water Resources Control Board
10 Salinas Valley Water Advisory Commission
8 Individual Growers
8 Other: 3-All of the above except the State, 1-All groups, 1-Equal group of growers, 2-No answer, 1-All of the above except the MCWRA

21. (IMPORTANT) Are there some actual physical or technological constraints which are stopping you from conserving additional water? (Manpower, time, efficiency limitations of sprinkler systems, etc.)

7 - Financial ability to implement available systems.
4 - Available time to install new systems.
4 - Limits of existing technology.
2 - Profit margins are too slim to justify implementation of new projects.
1 - Manpower limitations.
1 - Landlords will not allow improvement to the land.

AGGREGATE TOTAL SURVEY RESPONSES

22. (IMPORTANT) What financial considerations hinder you most from conserving additional water? (Cost of capital, overhead costs, etc.)
- 29 - Cost of capital.
 - 8 - Overhead costs limit my ability to implement new systems.
 - 6 - Slim profit margins limit my ability to invest in new projects.
 - 3 - Landowners are unwilling to share in the cost of new conservation.
 - 2 - Installation costs are prohibitive.
 - 1 - Banks are unwilling to loan money for conservation projects.
23. (IMPORTANT) What are the key political obstacles inhibiting better agricultural water management in the valley? (Lobbies, consensus, etc.)
- 8 - Lack of cooperation between north and south county growers.
 - 4 - Fear of Government intervention. (Forced metering/taxation)
 - 4 - Lack of leadership by the Board of Supervisors.
 - 4 - Lack of knowledge on water issues by some parties.
 - 3 - Lack of consensus on how to solve the water problems.
 - 3 - Self interested attitudes on the part of all parties.
 - 3 - Urban versus agriculture priority on water use .
24. What water conservation investments or changes in water management practices have you made in the last five years, and why did you do so?
- 18 - Conversion to drip irrigation.
 - 13 - More sprinkler systems. (Improvements to existing systems.)
 - 7 - Tailwater return systems.
 - 6 - Night/offwind irrigation.
 - 5 - 20% set aside program.
 - 4 - Laser leveling/land leveling.
 - 4 - Soil moisture meters.
 - 3 - New plastic pipelines.
 - 2 - Meters on all new wells.

AGGREGATE TOTAL SURVEY RESPONSES

25. What are the two most important concerns you have regarding the future of your agricultural water supplies?

- 26 - Quantity.
- 20 - Quality.
- 8 - Government intervention. (forced metering/restrictions)
- 6 - Lack of new water resources.
- 6 - High water costs.
- 3 - Agricultural versus urban water priorities in the future.
- 2 - Seawater intrusion.

26. Assuming the drought persists, what water conservation measure do you think would yield the greatest savings of groundwater?

- 23 - Mandatory acreage set aside.
- 10 - More conversion to drip irrigation.
- 7 - Expanded conservation measures.
- 4 - Metering of all wells.
- 3 - Fair allocation.
- 2 - Rationing water resources.
- 2 - A moratorium on all new water use.
- 1 - Limits on multiple cropping.

27. How would you like to see the current water problems resolved?

- 27 - A new reservoir.
- 7 - A mandatory set aside program.
- 7 - Metering of all wells.
- 4 - Cooperation between North and South Valley growers.
- 4 - Fair allocation.
- 4 - A moratorium on all new water use.
- 3 - Education and awareness.
- 2 - Absolute water rationing.
- 2 - Desalination for urban use.
- 1 - Expansion of conservation measures.
- 1 - Improve the existing reservoirs.
- 1 - Recycle "Grey water" for Agricultural use.

V. ANALYSIS OF THE DATA

A. INTRODUCTION

This chapter will analyze the data presented in Chapter IV and serve as the foundation for the conclusions presented in Chapter VI. The results of the survey form the basis for the analysis. Conclusions were drawn by looking at the participants' responses to the survey.

The following assumptions were used in performing the analysis:

- the responses of the sample population were useful in some cases for making qualified inferences about total population surveyed.
- the responses were representative of the experiences and attitudes of the individual growers and ranchers.
- it is human nature for each group to place most or all of the blame for problems on other groups or the system.

The analysis will focus on answering the primary research question of, "Why is it proving so difficult to implement more effective agricultural water management practices at the individual grower and rancher level?"

B. STATISTICAL ANALYSIS

The aggregate data was broken into five sub-categories for identification and analysis of barriers to effective agricultural water management. These include:

- Large operations (1000 acres or more).
- Medium operations (500-1000 acres).
- Small operations (less than 500 acres).
- North Valley geographic locations.
- South Valley geographic locations.

All of the individual farm/ranch operations data used in the preparation of the mail survey was derived from the MCWRA Agricultural Water Conservation Plan data base. Data on the physical location of each respondent's operation was unavailable, so mailing addresses were used to derive an approximate geographic location for the each respondent. It was also difficult to determine exactly where to divide the Salinas Valley into its North and South subsections. In this analysis, the Castroville, Spreckels, and Salinas areas were used to represent the views of the North Valley. The remaining Salinas Valley cities and locations were used to represent South Valley views. Table 5.1 displays the distribution of location, possible number of responses, actual number of responses, and the response rate percentages.

TABLE 5.1 SURVEY RESPONSE RATE

AREA	CITY	POSSIBLE	ACTUAL	PERCENT
NORTH	Castroville	13*	6	46%
	Spreckels	1	0	0%
	Salinas	95	19	20%
SOUTH	Chular	2	1	50%
	Gonzales	25	5	20%
	Soledad	43*	8	19%
	Greenfield	30	4	13%
	King City	25	8	32%
	San Lucus	2	0	0%
	San Ardo	10	1	10%
TOTAL	---	246	52	---

1. * Three of the incorrect address surveys were from Soledad. The other one was from Castroville.

Based on the data from the MCWRA, the total population of growers and ranchers consisted of 259 potential respondents. Nine of these were excluded from the survey because it was not possible to determine the geographic location of their operations from the mailing address of their headquarters. Four surveys returned due to incorrect mailing addresses.

Of the 246 surveys sent and actually received by potential respondents, 52 responses were returned by the cutoff date. This represents 21% of the total Salinas Valley agricultural grower/rancher population. Counting surveys received after the cutoff date, the response rate increased to 22% of the total population.

Table 5.2 displays the actual number of responses by size and geographic location sub-category.

TABLE 5.2 SURVEY RESPONSE BY SUB-CATEGORY

	NORTH	SOUTH	TOTAL
LARGE	10	10	20
MEDIUM	2	5	7
SMALL	13	12	25
TOTAL	25	27	52

The statistical breakdown for the 246 total "comparison population" by size category is as follows:

- 50 large sized operations (20% of comparison population)
- 41 medium sized operations (17% of comparison population)
- 155 small sized operations (63% of comparison population)

The actual number of returned surveys constitutes the "survey population" (a total of 52 responses). The "survey

population's" statistical breakdown by size category is as follows:

- 20 large sized operations (38% of survey population; representing a 40% total response rate)
- 7 medium sized operations (14% of survey population; representing a 17% total response rate)
- 25 small sized operations (48% of survey population; representing a 16% total response rate)

Based on the response rate for each size sub-category, we can conclude that any general comparisons that do not correct for size will be somewhat biased in favor of the large sized operations. Because this group had the highest response rate, their percentage proportion in the sample population is larger than their percentage proportion in the total population. This is depicted in Table 5.3 below.

TABLE 5.3 SURVEY VERSUS POPULATION PERCENTAGES

SIZE	POSSIBLE NUMBER	% OF TOTAL POPULATION	ACTUAL NUMBER	% OF SAMPLE POPULATION
LARGE	50	20%	20	38%
MEDIUM	41	17%	7	14%
SMALL	155	63%	25	48%
TOTAL	246	100%	52	100%

In order to compensate for the differences in the percentage proportions, a mathematical process was used to bias compensate the aggregate survey results. Therefore, the bias compensated aggregate survey results are representative of the total population. The process use to bias compensate the survey data will be explained with an example later in this chapter.

There was good agreement between the percentage proportions of the survey population and the total population for the geographic location sub-categories. Therefore, we can conclude that the any general comparisons based on geographic location will be representative of the total population. Table 5.4 below displays the geographic location sub-category data.

TABLE 5.4 RESPONSE RATE BY GEOGRAPHICAL LOCATION

AREA	POSSIBLE NUMBER	% OF TOTAL POPULATION	ACTUAL NUMBER	% OF SAMPLE POPULATION
NORTH	109	44%	25	48%
SOUTH	137	56%	27	52%
TOTAL	246	100%	52	100%

In the analysis of the survey data that follows, inferences about the total Salinas Valley grower/rancher population will only be drawn when the bias compensated data

clearly supports such inferences. The discussion will clearly indicate when the data supports such inferences.

C. DATA ANALYSIS

The analysis of the survey data that follows will use the aggregate total survey responses as it's basis. The questions will be analyzed sequentially in the order in which they appeared in the survey.

1. DEMOGRAPHIC BACKGROUND

The first five questions were used to gather demographic information. Demographic information was necessary in order to support the analysis of other survey data.

AGGREGATE TOTAL SURVEY RESPONSES

AGRICULTURAL WATER MANAGEMENT SURVEY

1. 51 Male
1 Female
2. Age: (2) 20-29 years old, (16) 30-39 years old, (17) 40-49 years old, (7) 50-59 years old, (8) 60-69 years old, (1) 70-79 years old, and (1) no answer
3. Ethnic background: 37-Caucasian, 2-German, 3-Italian, 1-Mexican, 2-European, 2-Japanese-American, 1-Japanese, 1-Swiss, 1-Danish, and 2-no answer
4. Highest level of education completed: (please mark only one response)

0 Grammar school level
13 High school level
32 B.S./B.A.
5 M.S./M.A.
1 Ph.D.
1 No answer

5. Political party affiliation: (please mark only one response)

- 7 Democratic party
- 35 Republican party
- 10 Other: 1-Libertarian, 7-Non Affiliated,
1-Independent, 1-Non-U.S. Citizen

The demographic questions provided some useful information on the sample population. Of the 52 respondents, 63% were in their 30's or 40's. Also, an impressive 73% of the sample population had college level degrees, with the majority of these degrees in fields related to agriculture. The overwhelming majority of respondents were Caucasian or other specific European nationalities. The response rate for Hispanic and Oriental ethnic backgrounds was less than expected, given the overall demographic makeup of the Salinas Valley. Finally, 67% of all respondents were politically affiliated with the Republican Party.

2. INTEREST GROUP AFFILIATION

Question six was designed to determine the types of interest groups, particularly water related interest groups, to which the Valley's individual grower/ranchers belong. The results demonstrate that the respondents were members of a broad range of interest groups.

6. Please mark the agricultural and/or water interest groups you belong to: (please mark those responses that apply)

- 31 Monterey County Farm Bureau
- 21 Grower Shipper Vegetable Association
- 10 Salinas Valley Water Advisory Commission
- 8 M.C. Agricultural Water Conservation Task Force
- 14 Salinas Valley Water Coalition
- 11 Other 2-Grape Grower's Assn., 1-M.C. Cattleman's Assn., 1-Irrigation Assn., 1-Iceberg Lettuce Research, 2-Western Grower's Assn., 1-CA. Assn of Family Farmers, 1-Backflow Commission, 1-Nitrate Commission, 1-M.C. Agricultural Education Commission

There were two particularly interesting observations to be made from the responses to question six. First, more than 50% of all respondents were members of some type of agricultural water commission, task force, coalition, or other water interest group. It would seem likely that growers and ranchers who were more pro-active in water related matters were also more likely to respond to a water management survey. Secondly, the survey respondents who were members of the Salinas Valley Water Coalition were predominately from the South Valley.

3. FARM OWNERSHIP

Question seven was designed to gather data on the types of farm ownership common in the Salinas Valley. The aim of the question was to determine the which type of operation was most often encountered.

7. With regard to this farm, I am: (please mark only one response)

- 12 Owner and sole proprietor
- 7 Tenant farmer
- 12 Farm manager for a corporate enterprise
- 2 Farm manager for a non-corporate partnership
- 16 Both own and lease farmland
- 3 Other: 1-Field Researcher, 1-General Partner,
1-Research Director for a seed company

The responses to question seven would indicate that some of the farming done in the Salinas Valley is being conducted on leased ground. This observation was also supported by a number of the comments in question 22 regarding the economic barriers to more water conservation. In question 22, a common response was that tenants felt the landowners were not sharing in the cost of implementing additional water conservation projects. The frequency of this response indicates that leased ground is not uncommon.

4. KNOWLEDGE OF WATER SUPPLY ISSUES

Question eight was designed to gauge the respondents' understanding of the composition of the Salinas Valley Groundwater Hydrologic Unit and it's associated aquifers. According to several hydrologists who have studied the Salinas Valley Groundwater Basin, the single homogenous groundwater aquifer in the southern part of the Valley becomes three "separate" aquifers north of Gonzales.¹³ (Miller '87, p. 2)

¹³An aquifer is a water-bearing layer of rock, sand, or gravel.

8. I believe that the Salinas Valley groundwater basin is served by: (please mark only one response)

- 21 A single common aquifer of varying depths
- 30 Unique isolated aquifers in various locations
- 0 Underground springs that are the source of groundwater
- 1 Other: 1-All of the above

In evaluating the results of the survey, it is important to note that the wording to the second answer may have been confusing. (The survey should have used the term separate aquifers vice unique isolated aquifers.) The most correct answer is the second answer. However, despite the choice of wording, over half of the respondents recognized the existence of unique aquifers in various locations. This finding supports the assertion that the survey population was reasonably well informed about the composition of the Salinas Valley Groundwater hydrologic unit.

Question nine was similarly designed to gauge respondent understanding of the "major" cause of the Valley's seawater intrusion problem. The focus of the question was to look for consensus of opinion on the main cause of seawater intrusion.

9. The major cause of the valley's seawater intrusion is: (please mark only one response)

- 12 Excessive pumping by coastal growers
- 36 Valley-wide overdrafting of the underground aquifer
- 2 A change to water intensive crops valley-wide
- 0 Seawater intrusion isn't a serious problem
- 0 A change to water intensive crops by coastal growers
- 2 Other: 1-Ag plus Urban Overuse, 1-Drought

According to the commission which studied the causes of seawater intrusion in 1987:

the increase in groundwater pumping all over the valley eventually caused groundwater levels to fall. In the northern part of the valley wells were first drilled into the upper 180' aquifer. Falling groundwater levels allowed seawater to move into that aquifer... and eventually into the 400' aquifer. (Miller '87, p. 3)

The two main causes of seawater intrusion are pumping near the seawater intrusion boundary and the lack of sufficient replenishment of fresh groundwater from other parts of the valley. (Miller '87, p. overview) Thus, the most correct answer was the second answer.

An impressive 70% of the sample population responded with this correct answer. In reality, a combination of factors interplay in causing the phenomenon of seawater intrusion, but this question was looking for acknowledgement by the respondents that seawater intrusion is a shared problem related to the existence of a single common hydrologic unit. Also, as would be expected from human nature, the respondents who marked excessive coastal pumping as the major cause of seawater intrusion were all South Valley growers/ranchers.

5. SOURCES OF WATER RELATED INFORMATION

Question ten was used to determine the predominant sources of information used by individual growers/ranchers to stay informed on water issues. By understanding the primary channels of communication, this research should help to improve communications between interested parties.

10. I stay informed on water management issues by: (indicate and rank all those that apply, beginning with 1 for the most used)

- 16 Newspaper
- 4 "Coffee shop" conversations
- 0 TV news programs
- 0 Radio
- 3 Magazines
- 5 Newsletters
- 18 Attendance at public meetings
- 6 Other:
 - 2-MCWRA contacts, 1-Direct contact with growers,
 - 2-No answer, 1-Farm Bureau contact

Since the respondents (as a group) did not rank the data, as requested in survey (there were numerous incomplete rankings), only the number one response from each respondent is included in the data summarized above. Table 5.5 displays the first, and second most common sources of information by the five size/location sub-categories.

TABLE 5.5 PRIMARY SOURCES OF INFORMATION

SOURCE	NORTH	SOUTH	LARGE	MEDIUM	SMALL
NEWSPAPER	2	2	2	2	1
PUBLIC MEETINGS	1	1	1	1	2

From the survey results, it can be observed that attendance at public meetings would rank high as a means of staying informed on water issues for the survey population. However, it may be likely that the total population is less pro-active and involved in attendance at public meetings those

who responded to the survey. In question six, over 50% of the respondents were actively involved in some water related interest group. This is a greater percentage involvement than exists in the total target population. Note: attendance at public meetings was estimated from observations made at several public meetings and by interviews with key participants on the subject of grower involvement in public meetings.

6. PERCEPTIONS REGARDING WATER SUPPLY ISSUES

For questions 11-19, graphic representations of the data were developed depicting the percentages of each sub-category population that agreed, had no opinion, or disagreed with the given statement. The strength of agreement or disagreement was disregarded for ease of analysis. Also, the aggregate total percentages were bias compensated as shown in the following example, using hypothetical responses to a question:

	AGGREGATE	LARGE	MEDIUM	SMALL	
AGREE	16	8	0	8	
n	52	20	7	25	SURVEY POPULATION
N	246	50	41	155	TOTAL POPULATION

If the agreement rates within each size category are extended to the entire population, the following computation gives the number of growers/ranchers who would agree with this question:

$$(8/20)*50 + (0/7)*41 + (8/25)*155 = 69.60$$

This represents the following fraction of the population:

$69.60/246=28.29$ or 28% (aggregate percentage with bias compensation)

Without the bias compensation process the percentage would be:

$16/52=30.77$ or 31% (aggregate percentage without bias compensation)

11. We are in danger of depleting the groundwater reserves in the valley as we end this fifth year of drought. (please mark only one response)

- 14 Strongly agree
- 16 Agree
- 3 No opinion
- 18 Disagree
- 1 Strongly disagree

There was general agreement among the sample group that we are in danger of depleting the groundwater reserves in the Valley, as depicted in Figure 5.1.

Question Eleven Percentages

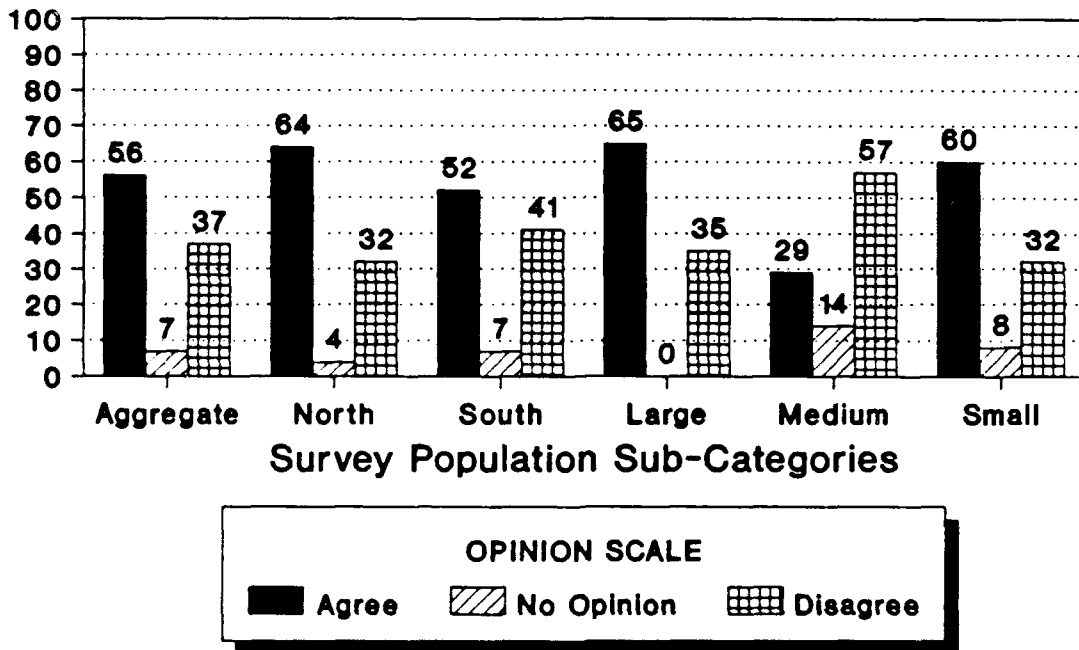


Figure 5.1 Question Eleven Percentages

Most of the sub-category group percentages were in very close agreement with the aggregate percentages, the exception being the Medium sized operations. The important observation we can make from this question is that there was nearly Valley-wide agreement that we are in a serious groundwater situation. Also, there was an implied acknowledgement that the Salinas Valley groundwater reserves are finite and exhaustible. The results support the assertion that the sample population was generally well informed

regarding the magnitude of the "overdraft problem" in the Salinas Valley.

12. I observe that my neighboring growers are very diligent in their daily water management. (please mark only one response)

5	Strongly agree
19	Agree
15	No opinion
11	Disagree
2	Strongly disagree

There was general agreement that neighboring growers were diligent in their daily water management, with the Large growers showing stronger agreement, and the Medium growers showing general disagreement, as depicted in Figure 5.2.

Question Twelve Percentages

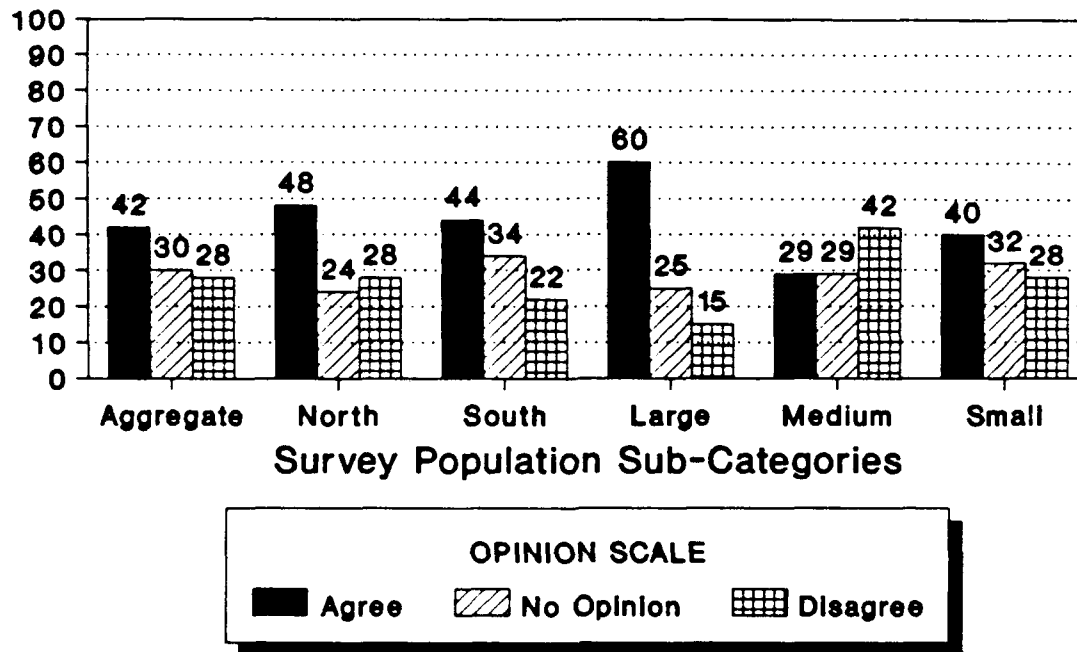


Figure 5.2 Question Twelve Percentages

One observation from this question is the high rate of no opinion responses. (This question had the highest no opinion response rate of any question.) One possible interpretation is that respondents chose to avoid committing themselves on the subject.

13. The water requirements for a given crop type significantly enter into my decision making when I am choosing my crop mix. (please mark only one response)

- 9 Strongly agree
- 11 Agree
- 9 No opinion
- 15 Disagree
- 8 Strongly disagree

This question had some interesting variation in responses between the sub-categories, as shown in Figure 5.3.

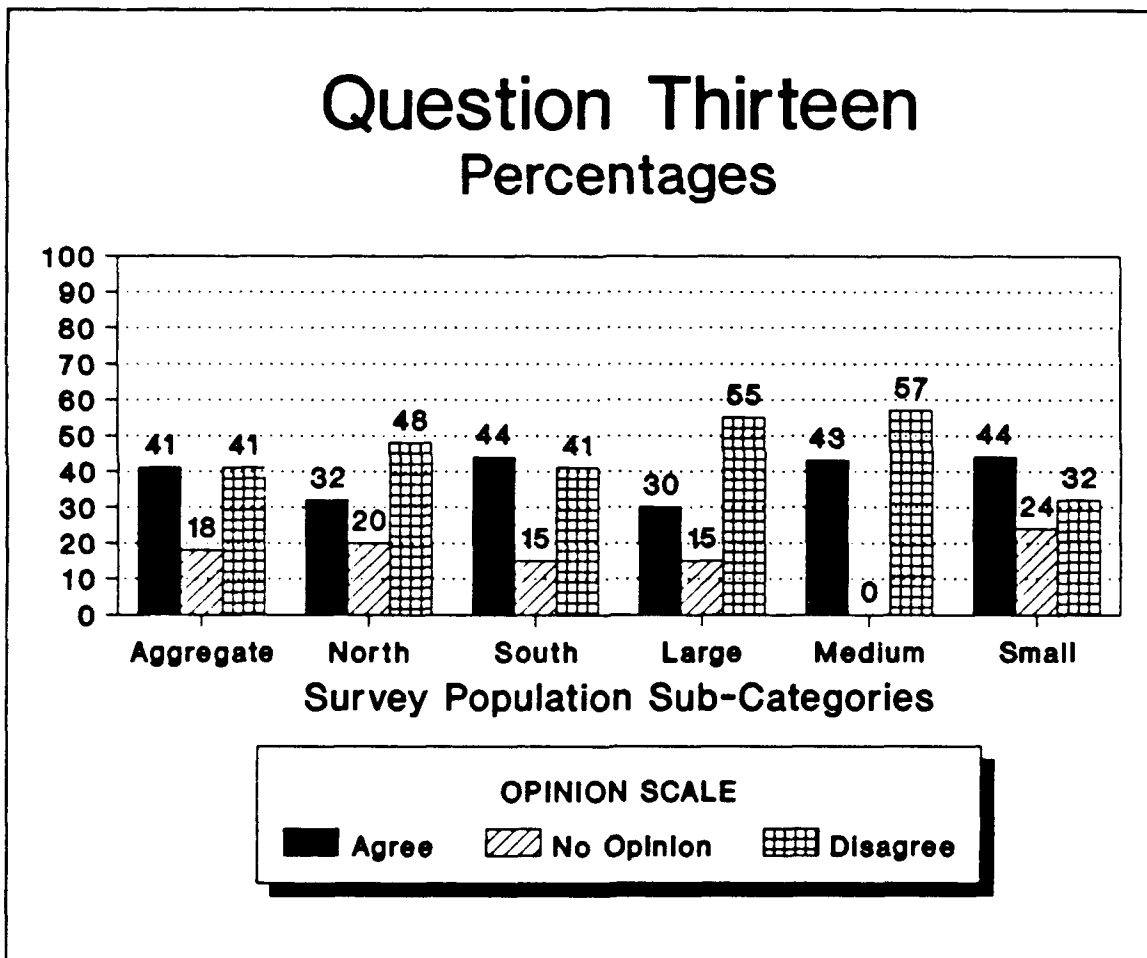


Figure 5.3 Question Thirteen Percentages

In the aggregate, the results showed that water requirements are not the primary driver in determining crop mix on a given parcel of land. The South Valley growers, and Small growers indicated more consideration of water requirements. Sensitivity to pumping costs by Small growers and increased water requirements for South Valley growers due to climatic differences as described in Chapter II might explain the divergence of opinion among the sub-categories.

14. The agricultural community in the Salinas Valley has the cohesiveness to resolve the current water problems on it's own. (please mark only one response)

9 Strongly agree
14 Agree
2 No opinion
18 Disagree
9 Strongly disagree

There was some disagreement with this statement, as depicted in Figure 5.4.

Question Fourteen Percentages

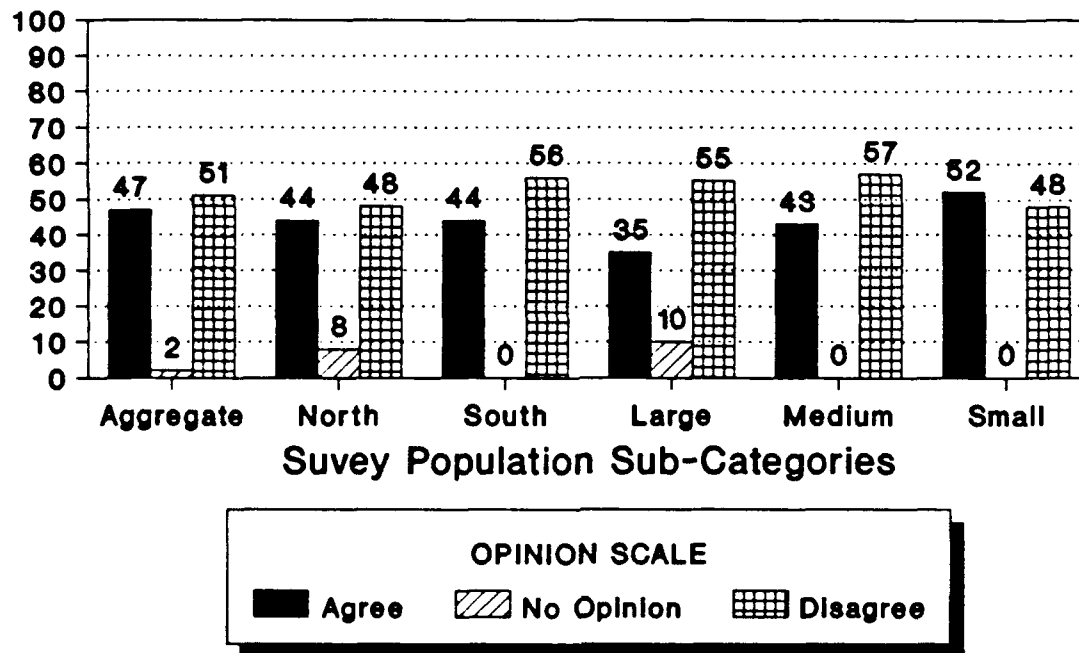


Figure 5.4 Question Fourteen Percentages

Most of the sub-categories agree with the aggregate results which indicate that the agricultural community does not have the cohesiveness to resolve the current water problems on their own. The exception is the Small growers sub-category.

15. I consider pumped water a common resource, in that each grower's use has a direct impact on other growers. (please mark only one response)

- 22 Strongly agree
- 24 Agree
- 1 No opinion
- 5 Disagree
- 0 Strongly disagree

There was overwhelming agreement that each grower's water use has a direct impact on other growers, as depicted in Figure 5.5.

Question Fifteen Percentages

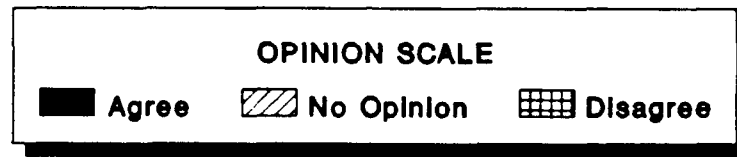
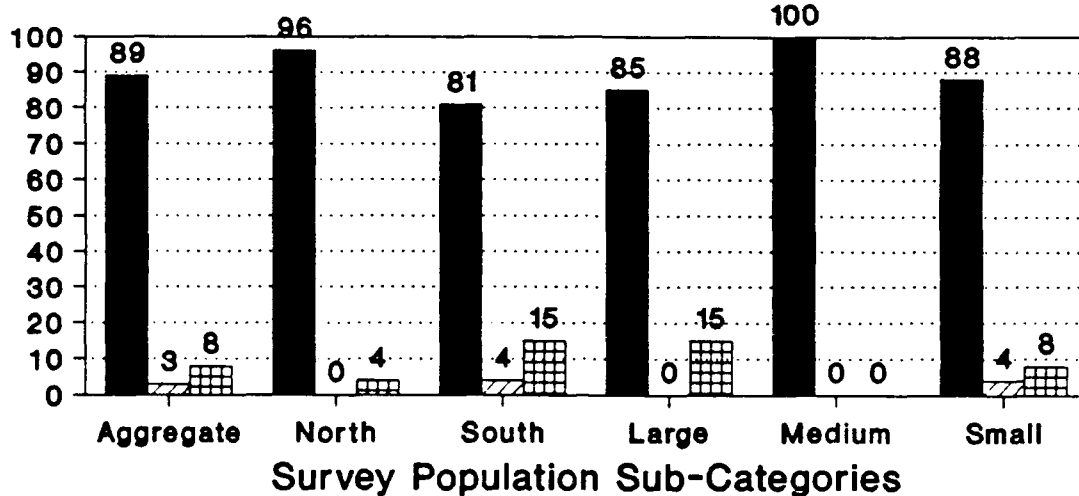


Figure 5.5 Question Fifteen Percentages

The importance of this affirmation is that it provides evidence concerning the growers' awareness of the fact that they all share a single common hydrologic unit, and that their actions affect the welfare of their neighbors (the common resource problem). The strength of these results, along with those of questions eight and nine, support an inference that the total population is generally aware of hydrologic make-up

of the underground aquifer, and the interdependence of their actions on other water users.

16. I believe that a mandatory acreage set-aside program is the best water saving alternative for ensuring that an equal conservation burden is shared by all growers.
(please mark only one response)

8 Strongly agree
10 Agree
1 No opinion
18 Disagree
15 Strongly disagree

This question was designed to evaluate the respondents' attitudes toward an acreage set-aside program. As Figure 5.6 depicts, the sub-category groups closely matched the aggregate results, with fairly strong disapproval of the idea of an acreage set-aside program.

Question Sixteen Percentages

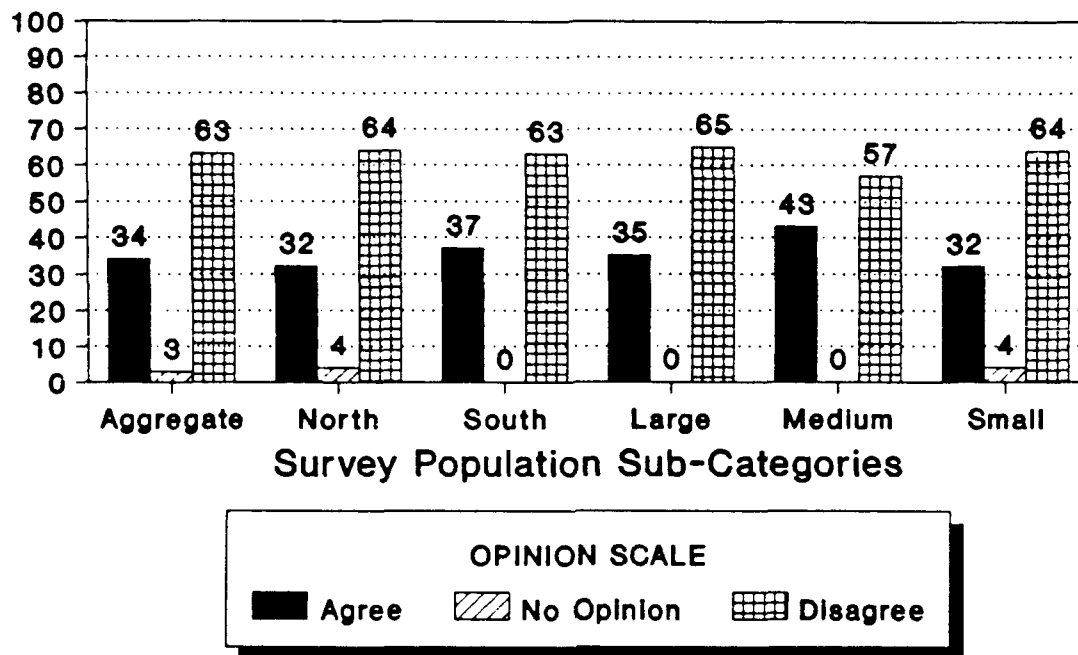


Figure 5.6 Question Sixteen Percentages

There was nearly even uniformity of opinion among the sub-categories on this question. The results of this question coupled with the results of question 26 would indicate that although averse to a set-aside program, the respondents were even more averse to metering for the purpose of allocation of water resources.

17. I am in favor of metering wells as a means of monitoring individual water use for the purpose of allocating groundwater resources. (please mark only one response)

- 10 Strongly agree
- 8 Agree
- 3 No opinion
- 15 Disagree
- 16 Strongly disagree

This question was designed to evaluate the respondents' attitudes toward a well metering program. The distribution of responses in all categories was similar to that found in the previous question, with some interesting differences. The results are depicted in Figure 5.7.

Question Seventeen Percentages

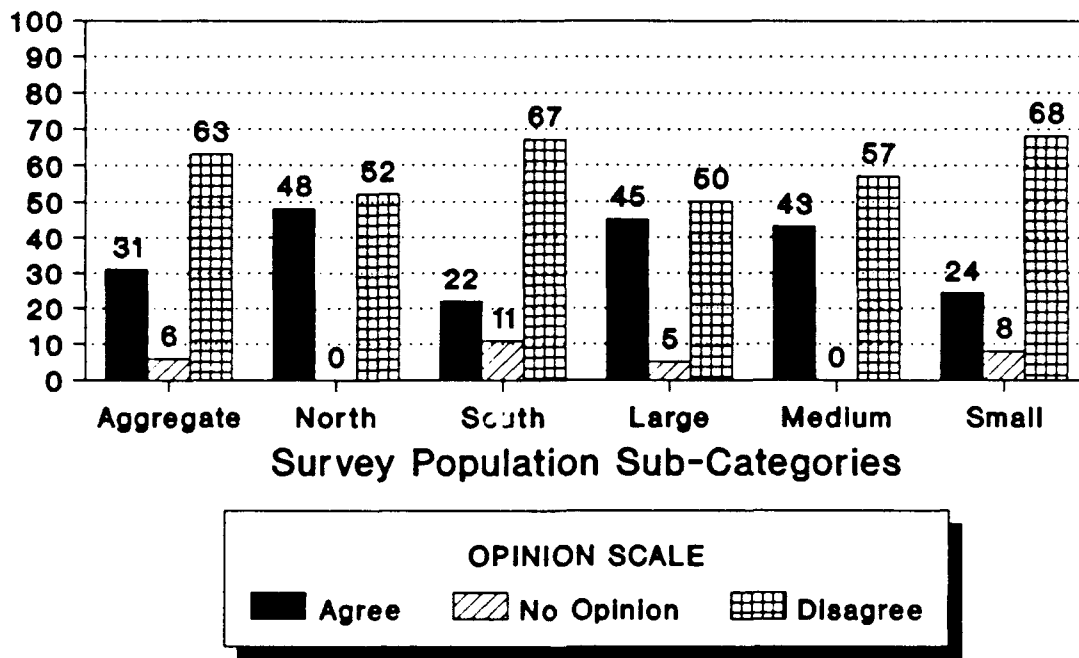


Figure 5.7 Question Seventeen Percentages

The South Valley growers were strongly opposed to well metering for allocating water resources. The Small growers were also strongly opposed to this idea. Further research is needed to determine the reasons for the two sub-categories opinions. One very important observation to make here is that the Small growers would most likely be more economically affected than any other sub-category by a well metering requirement.

18. Most growers that I know attempt to conserve groundwater, so that they will have sufficient groundwater levels 20-30 years from now. (please mark only one response)

- 9 Strongly agree
- 19 Agree
- 5 No opinion
- 17 Disagree
- 2 Strongly disagree

There was general agreement between the results of the sub-categories and the aggregate data. The North Valley growers displayed a stronger affirmative opinion as depicted in Figure 5.8.

Question Eighteen Percentages

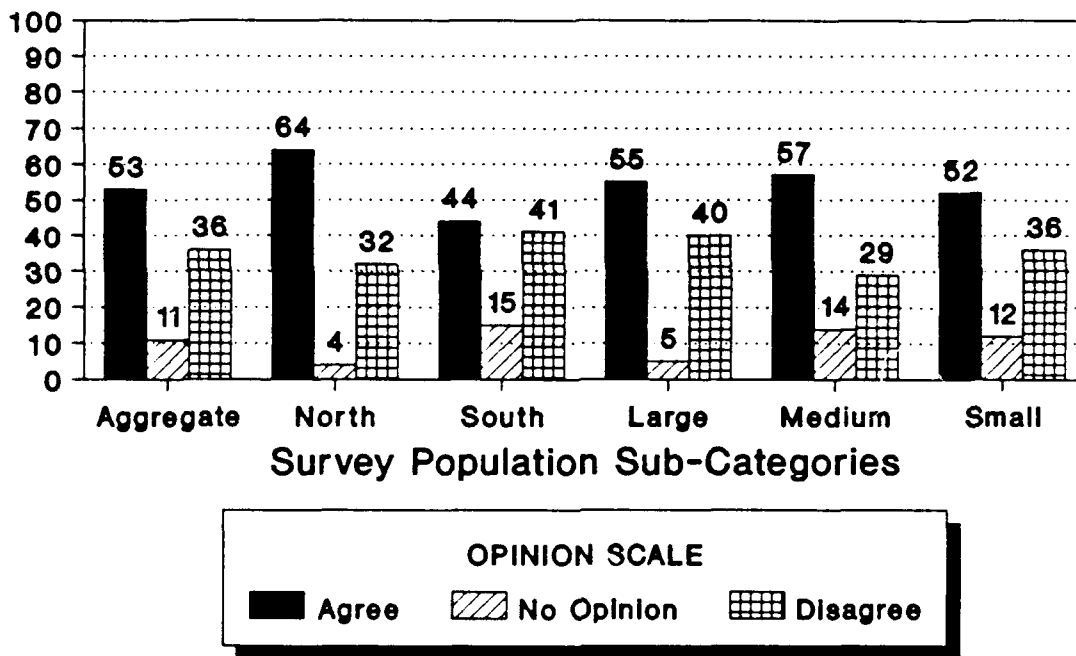


Figure 5.8 Question Eighteen Percentages

As expected, the North Valley growers, who are more affected by availability and water quality problems, were more concerned with the future of their water supplies. They felt that they are being more conscientious as a group than the aggregate sample population. This raises the question of whether current groundwater availability affects attitudes toward conservation.

19. I feel there is a need to formulate a long term water management plan for the Salinas Valley. (please mark only one response)

37 Strongly agree
10 Agree
1 No opinion
2 Disagree
2 Strongly disagree

There was a large degree of support for the need to formulate a long term water management plan, as depicted in Figure 5.9.

Question Nineteen Percentages

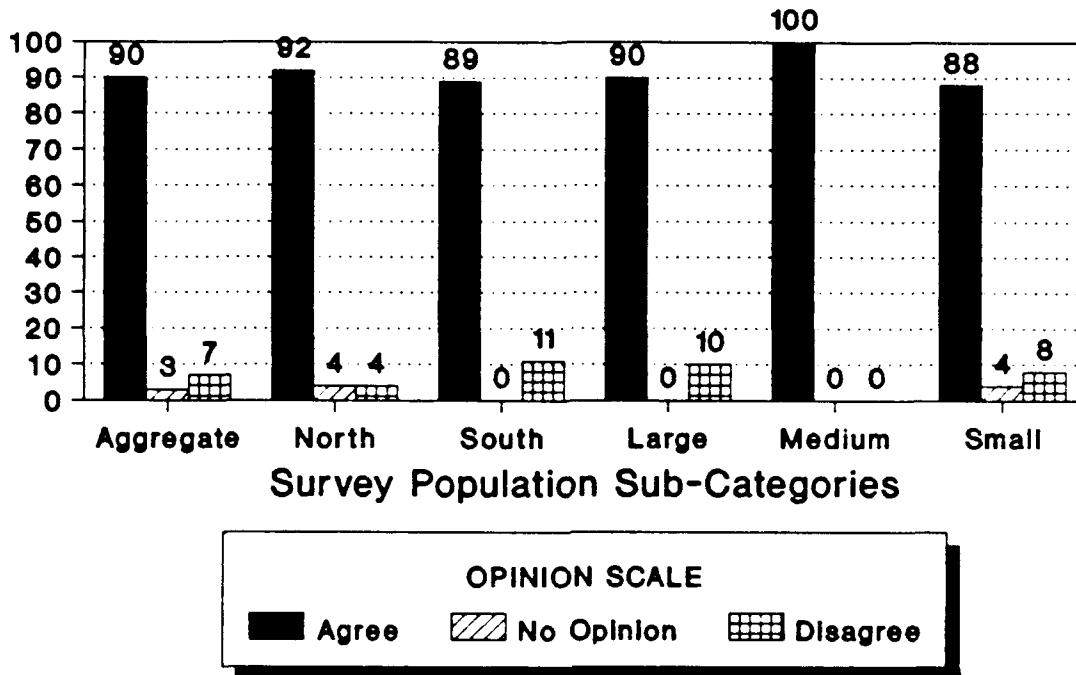


Figure 5.9 Question Nineteen Percentages

There was a small amount of disagreement with the idea of a long term water management plan. As the data shows the South Valley growers displayed the greatest aversion to a long term water management plan. However, based upon the strength of affirmation on this issue, it is reasonable to infer that the total population would also agree with the general need for a long term water management plan.

20. Who do you feel should take the leadership role in management of water resources in the Salinas Valley? (please mark only one response)

- 12 Monterey County Water Resources Agency
- 1 County Board of Supervisors
- 13 Board of Directors of the Monterey County Water Resources Agency
- 0 State Water Resources Control Board
- 10 Salinas Valley Water Advisory Commission
- 8 Individual Growers
- 8 Other: 3-All of the above except the State, 1-All groups, 1-Equal group of growers, 2-No answer, 1-All of the above except the MCWRA

The aggregate results indicate that the respondents acknowledge the role of the recently formed Board of Directors of the Monterey County Water Resources Agency as the body which should take the leadership role in managing the water resources of the Salinas Valley. All of the sub-category groups indicated a preference similar to the aggregate results.

1. BARRIERS AFFECTING AGRICULTURAL WATER MANAGEMENT

All of the barriers to more effective agricultural water management are interrelated and are influenced to some degree by financial factors. The responses to this survey and the personal interviews indicate that the single most significant factor influencing the attitude and behavior of individual growers and ranchers was costs.

Questions 21-23 address a number of barriers to more effective agricultural water management. The data presented was interpreted and summarized from completed surveys. Not all respondents chose to answer all of these questions.

21. (IMPORTANT) Are there some actual physical or technological constraints which are stopping you from conserving additional water? (Manpower, time, efficiency limitations of sprinkler systems, etc.)

- 7 - Financial ability to implement available systems.
- 4 - Available time to install new systems.
- 4 - Limits of existing technology.
- 2 - Profit margins are too slim to justify implementation of new projects.
- 1 - Manpower limitations.
- 1 - Landlords will not allow improvement to the land.

As evidenced by the data, the physical ability to conserve water resources was directly or indirectly related to financial factors. A number of growers indicated a desire to do more to conserve groundwater, but were limited by financial considerations.

22. (IMPORTANT) What financial considerations hinder you most from conserving additional water? (Cost of capital, overhead costs, etc.)

- 29 - Cost of capital.
- 8 - Overhead costs limit my ability to implement new systems.
- 6 - Slim profit margins limit my ability to invest in new projects.
- 3 - Landowners are unwilling to share in the cost of new conservation.
- 2 - Installation costs are prohibitive.
- 1 - Banks are unwilling to loan money for conservation projects.

The number one response was cost of capital. It can be inferred that this would also hold true for the total population. The remainder of the responses are all examples of financial factors. Most of the respondents indicated that they were making a few investments in new conservation projects, but were prevented by financial constraints from

achieving the level of irrigation efficiency that they would like to see.

Interviews with Agricultural Industry officials, and research on the increase of foreign competition, indicates that profit margins on a number of Salinas Valley crops are declining. It is consequently not surprising that the local banks are not eager to loan money for projects that they think will have a long payback period. Other than the benefit of reduced pumping costs, there are no current financial incentives for the growers to invest in conservation. This fact has resulted in the continuing drawdown of the finite groundwater reserves of the Salinas Valley aquifer.

Regarding leased land, the full cost of conservation investments continues to be born by the tenant growers. Most landowners who lease-out farmland are escaping direct responsibility for ensuring the future of our groundwater supplies. Thus, there is no immediate incentive for landowners or tenants to invest in conservation projects.

23. (IMPORTANT) What are the key political obstacles inhibiting better agricultural water management in the valley? (Lobbies, consensus, etc.)

- 8 - Lack of cooperation between north and south valley growers.
- 4 - Fear of Government intervention. (Forced metering/taxation)
- 4 - Lack of leadership by the Board of Supervisors.
- 4 - Lack of knowledge on water issues by some parties.
- 3 - Lack of consensus on how to solve the water problems.
- 3 - Self interested attitudes on the part of all parties.
- 3 - Urban versus agriculture priority on water use.

The data indicates that resolving the differences of opinion between the north and south valley growers is the most important political barrier to overcome. The most common concern expressed over government intervention was that of forced metering and subsequent water price increases through a water use tax. Growers fear that a government regulated solution will force them out of business, since local production cost increases would diminish their ability to compete in an increasingly competitive international produce market. There was a general acknowledgement of a need to do something about the current water problems, but there is concern about how governmental action will affect the livelihoods of individual growers and ranchers.

2. RECENT WATER CONSERVATION INVESTMENTS

This question was designed to determine what types of conservation efforts were most widely used by the respondents. The question focused on changes that have occurred in the last five years.

24. What water conservation investments or changes in water management practices have you made in the last five years, and why did you do so?

- 18 - Conversion to drip irrigation.
- 13 - More sprinkler systems. (Improvements to existing systems.)
- 7 - Tailwater return systems.
- 6 - Night/offwind irrigation.
- 5 - 20% set-aside program.
- 4 - Laser leveling/land leveling.
- 4 - Soil moisture meters.
- 3 - New plastic pipelines.
- 2 - Meters on all new wells.

These answers indicate that some progress is being made toward achieving more agricultural water conservation. However, these gains are both too small and too slow to be totally effective in reversing the "overdraft" problem in the Salinas Valley. New irrigation technologies and the use of government regulations are the only means currently being used to conserve our groundwater reserves. Therefore, it is probable that hard choices will have to be made over whether to limit agricultural production or overcome the obstacles associated with developing new groundwater resources.

3. GREATEST WATER CONCERNS

This question examines the respondent's two greatest water concerns. It attempts to identify and quantify the issues which are most troubling to the individual growers and ranchers.

25. What are the two most important concerns you have regarding the future of your agricultural water supplies?

- 26 - Quantity.
- 20 - Quality.
- 8 - Government intervention. (forced metering/restrictions)
- 6 - Lack of new water resources.
- 6 - High water costs.
- 3 - Agricultural versus urban water priorities in the future.
- 2 - Seawater intrusion.

The overwhelming majority of all respondents indicated that quantity and quality were equally the two most important concerns they had regarding the future of their water supplies. There is little doubt that the first two responses

would also be the two most important concerns of the total population. The third response supports the data in question 23 above. The remainder of the responses are more specific, but similar in content to the first two responses.

The concerns raised in this question add validity to the primary research question. If the individual growers and ranchers really are most concerned about the quantity and quality of their future water supplies, then why is it proving so difficult to achieve more effective agricultural water management practices at the individual grower and rancher level?

The real issue at hand is how the growers and ranchers can remain competitive today, while preserving their existing groundwater resources and/or developing new groundwater resources to ensure the future of the Salinas Valley. To do nothing is becoming less of an option, with or without the drought.

4. BEST WATER CONSERVATION MEASURES

This question asked the respondents to express their opinion on the best water saving measure, if further conservation measures become necessary due to the drought. The question sought to determine whether the opinion would be influenced by present circumstances and geographic location.

26. Assuming the drought persists, what water conservation measure do you think would yield the greatest savings of groundwater?

- 23 - Mandatory acreage set-aside.
- 10 - More conversion to drip irrigation.
- 7 - Expanded conservation measures.
- 4 - Metering of all wells.
- 3 - Fair allocation.
- 2 - Rationing water resources.
- 2 - A moratorium on all new water use.
- 1 - Limits on multiple cropping.

The North Valley favored set-aside, more drip irrigation, and metering wells as their top choices. The South Valley favored set-aside, more drip systems, and expansion of existing conservation practices as their top choices. This question points out an interesting paradox in that while respondents viewed set-aside as the most effective water saving measure, they have also expressed their strong aversion to the type of government intervention this measure would require. Perhaps under the more dire conditions postulated in the question, the growers would be more willing to consent to some form of government intervention.

5. PREFERRED OUTCOMES

The last question sought to give the respondents a free hand at expressing their desires for solving the water problems of the Salinas Valley. The purpose of the question was to determine whether there would be consistency between the answers to this question and the previous questions.

27. How would you like to see the current water problems resolved?

- 27 - A new reservoir.
- 7 - A mandatory set aside program.
- 7 - Metering of all wells.
- 4 - Cooperation between North and South Valley growers.
- 4 - Fair allocation.
- 4 - A moratorium on all new water use.
- 3 - Education and awareness.
- 2 - Absolute water rationing.
- 2 - Desalination for urban use.
- 1 - Expansion of conservation measures.
- 1 - Improve the existing reservoirs.
- 1 - Recycle "grey water" for agricultural use.

There was strong support among respondents for a new reservoir. It seems clear that the respondents recognize a need for more water in the future, if the Valley is to maintain it's current rates of agricultural production. It is interesting that the members of the agricultural industry are very interested in a new water supply but have not actively worked to achieve this objective. The total number of respondents favoring a new reservoir by sub-category were: 13 North; 14 South; 11 Large; 4 Medium; and 12 Small. Relative to the number of respondents who chose to complete all of the survey questions, the response in favor of a new reservoir was consistently large.

The remainder of the responses to question 27 were consistent with the earlier parts of the survey. There were not any ideas generated that have not already been studied.

A. SUMMARY

The sample population represented the views of growers and ranchers who were more pro-active and better informed on groundwater issues. Based upon the number of returned surveys, the sample population was somewhat biased towards the Large growers and the North Valley views. However, by using bias compensation procedures, the views embodied by the sample population are probably representative of the total population.

The results of this survey provided a number of important observations. First, all of the barriers to more effective agricultural water management are significantly influenced by cost, and it seems to be the most important factor influencing individual grower/rancher attitudes and behaviors regarding groundwater conservation. Second, individual growers and ranchers tend to favor those changes which have the least economic impact on their farms. Third, respondents have a fear of government intervention, but recognize a growing need to do something about the current water problems. Fourth, there is a strong belief that a long range water management plan needs to be formulated. And finally, there is strong support among the respondents for the development of a new water storage reservoir.

VI. CONCLUSIONS AND RECOMMENDATIONS

This chapter will draw conclusions and make recommendations based upon the results of the data analyzed in Chapter V. The primary and secondary research questions will be answered and recommendations offered for the problems presented.

A. RESEARCH CONCLUSIONS AND RECOMMENDATIONS

The primary research question asked, "Why is it proving so difficult to implement more effective agricultural water management practices at the individual grower and rancher level?" The most significant barriers to more effective agricultural water management in the Salinas Valley appear to be:

- The high cost of capital relative to profit margins and rate of return on conservation investments. These costs have limited the financial ability of the individual grower and rancher to invest in groundwater conservation projects.
- The availability of capital. Respondents indicated that banks are hesitant to loan funds for water conservation projects because of the long payback periods involved.

- The relative value placed on groundwater reserves. In order of priority, the individual growers and ranchers are concerned with: staying in business in the short term; staying competitive against foreign producers; preserving their existing groundwater supplies; and developing new groundwater supplies. Faced with tough alternatives and mounting economic constraints, individual growers and ranchers place a higher value on their immediate economic future than on the environmental future of the aquifer.
- The Valley-wide lack of commitment to solving its groundwater problems. The degree of commitment to groundwater problems is predominately a function of the direct impact which these problems have had on individual growers and ranchers.
- The lack of financial incentives to invest in conservation. There are no incentives to make further gains in groundwater conservation at the present time.
- The lack of consensus and cooperation between all of the parties interested in groundwater management.

Based upon these conclusions, the following actions are recommended:

- The Monterey County Board of Supervisors and the leaders in the agricultural industry should use their influence to persuade the Area Banking Industry of the serious need for lower cost loans to implement irrigation efficiency improvements and groundwater conservation projects.
- The MCWRA should increase it's ongoing efforts to educate all of the Valley's residents on the seriousness of the Salinas Valley's current groundwater problems. This should be accomplished by emphasizing the development of the new long range water management plan, and by emphasizing the need for all county water users to be more informed and involved in developing solutions to the existing water problems. In the case of growers and ranchers, this effort should be targeted at the ways in which they obtain their information.
- The Monterey County Board of Supervisors should develop a program to provide incentives for those Valley water users who are actively investing in groundwater conservation. In the case of growers, the program should center around irrigation efficiency improvements. Also, progress should

be made toward getting landowners who lease their farmland more involved in groundwater conservation investments.

- And finally, the agricultural industry should act as a catalyst in gaining broad-based community support for the development of a new reservoir project or other viable alternatives to help meet the Salinas Valley's additional groundwater needs into the next century.

The secondary questions addressed the technological, financial, social, and political barriers to more effective agricultural water management. The analysis of these questions leads to the following conclusions:

- Financial factors are the driving force behind individual attitudes and behavior and are the overriding impediment to overcoming the physical or technological constraints, which limit more effective groundwater utilization.
- The reduction in profit margins and limited capital availability have constrained many growers desiring to invest in water conservation projects. Both of these factors have reduced the availability of funds at the individual grower and rancher level, limiting the potential for further gains in groundwater conservation.
- The individual grower and rancher level has a general fear of government involvement in solving the Valley's groundwater problems.
- Short-term interests are presently taking priority over the long-term interests of the affected parties concerned with the future of the Salinas Valley's groundwater supplies.
- The Salinas Valley faces a future which will require further water conservation gains and reduced agricultural production, or the development of new sources of groundwater. The County Board of Supervisors must act soon if they are to eliminate the threat of the advancing seawater intrusion front.

Based upon these conclusions, the following actions are recommended:

- The Monterey County Board of Supervisors should develop a matching funds program aimed at reducing the cost of capital needed for groundwater conservation projects by conservation minded Valley water users.
- The MCWRA should research and derive equitable formulas for implementing new groundwater conservation initiatives. This research should include studies of the percentage of cost to be born by the county and the individual water users.
- The MCWRA should acquire the manpower needed to enforce existing groundwater conservation programs. This will promote more responsible behavior on the part of all water wasters.
- The MCWRA should enforce (and expand as conditions warrant) existing water conservation measures until new sources of groundwater are developed.

B. RECOMMENDATIONS FOR FURTHER STUDY

The following areas of study would be useful in helping to resolve the current water problems of the Salinas Valley:

- A study of the Salinas Valley Groundwater Basin aimed at determining constituent support for the development of a new reservoir for groundwater storage.
- A study which looks at the cost of capital relative to profit margins, and its impact on water conservation investments at the individual grower and rancher level.
- A study aimed at determining the knowledge about and the personal involvement in water issues of all water users in the Salinas Valley.

APPENDIX A SAMPLE SURVEY

**AGRICULTURAL
WATER MANAGEMENT SURVEY**

Dear Mr. Jones,

My name is Lieutenant Commander Bob Pottberg. I am a financial management student at the Naval Postgraduate School, in Monterey. I am writing a thesis on agricultural water management issues in the Salinas Valley.

I own a small farm in Colorado, and have noticed that water issues are becoming front page news throughout the West, and particularly in the agriculturally intensive Salinas Valley. I desire to learn more about the serious implications of agricultural water management issues, as seen from the perspective of the individual grower or rancher. This survey, and subsequent personal interviews will be the basis of my research effort in this regard.

As an independent party, I offer you the perspective of being unbiased, and able to "tell it like it is" in a formal thesis, which will be distributed to selected academic and government organizations.

Let your views be made known! A viable solution to agricultural water issues is only possible by understanding all of the barriers to effective water management, in order to work out equitable solutions that are in the best interest of everyone's future.

Your specific survey responses will be kept strictly confidential. I desire your honest input.

Sincerely,

LCDR Bob Pottberg

I need your support! I'd like to have equal representation from all parts of the Salinas Valley. Please complete ALL or part of this survey, and return your completed survey in the enclosed pre-stamped envelope to:

Superintendent (Code 36)
Naval Postgraduate School
Monterey, CA 93943-5000

SAMPLE SURVEY
AGRICULTURAL
WATER MANAGEMENT SURVEY

(Survey responses are confidential. Call Lcdr Bob Pottberg after 5 p.m. at (408) 373-3406 if you have any questions.)

DARKEN IN THE CIRCLES FOR ALL RESPONSES WHICH APPLY

1. ☐ Male 2.
 Age _____
 ☐ Female
3. Ethnic background: _____
4. Highest level of education completed: (please mark only one response)
 ☐ Grammar school level
 ☐ High school level
 ☐ B.S./B.A. in _____
 ☐ M.S./M.A. in _____
5. Political party affiliation: (please mark only one response)
 ☐ Democratic party
 ☐ Republican party
 ☐ Other _____
6. Please mark the agricultural and/or water interest groups you belong to: (please mark those responses that apply)
 ☐ Monterey County Farm Bureau
 ☐ Grower Shipper Vegetable Association
 ☐ Salinas Valley Water Advisory Commission
 ☐ M.C. Agricultural Water Conservation Task Force
 ☐ Salinas Valley Water Coalition
 ☐ Other _____

 ☐ Other _____
7. With regard to this farm, I am: (please mark only one response)
 ☐ Owner and sole proprietor
 ☐ Tenant farmer
 ☐ Farm manager for a corporate enterprise
 ☐ Farm manager for a non-corporate partnership
 ☐ Both own and lease farmland
 ☐ Other _____

SAMPLE SURVEY

8. I believe that the Salinas Valley groundwater basin is served by: (please mark only one response)
- ☐ A single common aquifer of varying depths
 - ☐ Unique isolated aquifers in various locations
 - ☐ Underground springs that are the source of groundwater
 - ☐ Other _____
9. The major cause of the valley's seawater intrusion is: (please mark only one response)
- ☐ Excessive pumping by coastal growers
 - ☐ Valley-wide overdrafting of the underground aquifer
 - ☐ A change to water intensive crops valley-wide
 - ☐ Seawater intrusion isn't a serious problem
 - ☐ A change to water intensive crops by coastal growers
 - ☐ Other _____
10. I stay informed on water management issues by: (indicate and rank all those that apply, beginning with 1 for the most used)
- ☐ Newspaper (ranking) _____
 - ☐ "Coffee shop" conversations (ranking) _____
 - ☐ TV news programs (ranking) _____
 - ☐ Radio (ranking) _____
 - ☐ Magazines (ranking) _____
 - ☐ Newsletters (ranking) _____
 - ☐ Attendance at public meetings (ranking) _____
 - ☐ Other _____ (ranking) _____
11. We are in danger of depleting the groundwater reserves in the valley as we end this fifth year of drought. (please mark only one response)
- ☐ Strongly agree
 - ☐ Agree
 - ☐ No opinion
 - ☐ Disagree
 - ☐ Strongly disagree
12. I observe that my neighboring growers are very diligent in their daily water management. (please mark only one response)
- ☐ Strongly agree
 - ☐ Agree
 - ☐ No opinion
 - ☐ Disagree
 - ☐ Strongly disagree

SAMPLE SURVEY

13. The water requirements for a given crop type significantly enter into my decision making when I am choosing my crop mix. (please mark only one response)
- ☐ Strongly agree
 - ☐ Agree
 - ☐ No opinion
 - ☐ Disagree
 - ☐ Strongly disagree
14. The agricultural community in the Salinas Valley has the cohesiveness to resolve the current water problems on it's own. (please mark only one response)
- ☐ Strongly agree
 - ☐ Agree
 - ☐ No opinion
 - ☐ Disagree
 - ☐ Strongly disagree
15. I consider pumped water a common resource, in that each grower's use has a direct impact on other growers. (please mark only one response)
- ☐ Strongly agree
 - ☐ Agree
 - ☐ No opinion
 - ☐ Disagree
 - ☐ Strongly disagree
16. I believe that a mandatory acreage set-aside program is the best water saving alternative for ensuring that an equal conservation burden is shared by all growers. (please mark only one response)
- ☐ Strongly agree
 - ☐ Agree
 - ☐ No opinion
 - ☐ Disagree
 - ☐ Strongly disagree
17. I am in favor of metering wells as a means of monitoring individual water use for the purpose of allocating groundwater resources. (please mark only one response)
- ☐ Strongly agree
 - ☐ Agree
 - ☐ No opinion
 - ☐ Disagree
 - ☐ Strongly disagree

SAMPLE SURVEY

18. Most growers that I know attempt to conserve groundwater, so that they will have sufficient groundwater levels 20-30 years from now. (please mark only one response)
- ☐ Strongly agree
 - ☐ Agree
 - ☐ No opinion
 - ☐ Disagree
 - ☐ Strongly disagree
19. I feel there is a need to formulate a long term water management plan for the Salinas Valley. (please mark only one response)
- ☐ Strongly agree
 - ☐ Agree
 - ☐ No opinion
 - ☐ Disagree
 - ☐ Strongly disagree
20. Who do you feel should take the leadership role in management of water resources in the Salinas Valley? (please mark only one response)
- ☐ Monterey County Water Resources Agency
 - ☐ County Board of Supervisors
 - ☐ Board of Directors of the Monterey County Water Resources Agency
 - ☐ State Water Resources Control Board
 - ☐ Salinas Valley Water Advisory Commission
 - ☐ Individual Growers
 - ☐ Other _____
21. (IMPORTANT) Are there some actual physical or technological constraints which are stopping you from conserving additional water? (Manpower, time, efficiency limitations of sprinkler systems, etc.)
22. (IMPORTANT) What financial considerations hinder you most from conserving additional water? (Cost of capital, overhead costs, etc.)

SAMPLE SURVEY

23. (IMPORTANT) What are the key political obstacles inhibiting better agricultural water management in the valley? (Lobbies, consensus, etc.)
24. What water conservation investments or changes in water management practices have you made in the last five years, and why did you do so?
25. What are the two most important concerns you have regarding the future of your agricultural water supplies?
26. Assuming the drought persists, what water conservation measure do you think would yield the greatest savings of groundwater?
27. How would you like to see the current water problems resolved?

ANY ADDITIONAL COMMENTS ARE CERTAINLY WELCOME! Thanks, Bob

APPENDIX B NORTH SUB-CATEGORY

NORTH VALLEY TOTAL SURVEY RESPONSES

**AGRICULTURAL
WATER MANAGEMENT SURVEY**

1. 25 Male
0 Female
2. Age: (9) 30-39 years old, (10) 40-49 years old, (3) 50-59 years old, (3) 60-69 years old
3. Ethnic background: 19-Caucasian, 1-European, 2-Italian, 1-Japanese, 2 Japanese-American
4. Highest level of education completed: (please mark only one response)

0 Grammar school level
4 High school level
17 B.S./B.A.
3 M.S./M.A.
0 Ph.D.
1 No answer
5. Political party affiliation: (please mark only one response)

4 Democratic party
15 Republican party
6 Other: 1-Libertarian, 3-Non Affiliated, 1-Independent, 1-Non U.S. Citizen
6. Please mark the agricultural and/or water interest groups you belong to: (please mark those responses that apply)

12 Monterey County Farm Bureau
12 Grower Shipper Vegetable Association
6 Salinas Valley Water Advisory Commission
3 M.C. Agricultural Water Conservation Task Force
4 Salinas Valley Water Coalition
6 Other: 1-Iceberg Lettuce Research, 1-Western Grower's Assn., 1-CA. Assn. of Family Farmers, 1-Backflow Commission, 1-Nitrate Commission, 1-M.C. Agricultural Education Commission

NORTH VALLEY TOTAL SURVEY RESPONSES

7. With regard to this farm, I am: (please mark only one response)

- 6 Owner and sole proprietor
- 3 Tenant farmer
- 6 Farm manager for a corporate enterprise
- 1 Farm manager for a non-corporate partnership
- 8 Both own and lease farmland
- 1 Other: 1-Research Director for a seed company

8. I believe that the Salinas Valley groundwater basin is served by: (please mark only one response)

- 7 A single common aquifer of varying depths
- 18 Unique isolated aquifers in various locations
- 0 Underground springs that are the source of groundwater
- 0 Other:

9. The major cause of the valley's seawater intrusion is: (please mark only one response)

- 4 Excessive pumping by coastal growers
- 19 Valley-wide overdrafting of the underground aquifer
- 1 A change to water intensive crops valley-wide
- 0 Seawater intrusion isn't a serious problem
- 0 A change to water intensive crops by coastal growers
- 1 Other: 1-Drought

10. I stay informed on water management issues by: (indicate and rank all those that apply, beginning with 1 for the most used)

- 9 Newspaper (ranking) _____
- 2 "Coffee shop" conversations (ranking) _____
- 0 TV news programs (ranking) _____
- 0 Radio (ranking) _____
- 1 Magazines (ranking) _____
- 2 Newsletters (ranking) _____
- 10 Attendance at public meetings (ranking) _____
- 1 Other: (ranking) _____
- 1-Direct contact with growers

NORTH VALLEY TOTAL SURVEY RESPONSES

11. We are in danger of depleting the groundwater reserves in the valley as we end this fifth year of drought. (please mark only one response)

8 Strongly agree
8 Agree
1 No opinion
8 Disagree
0 Strongly disagree

12. I observe that my neighboring growers are very diligent in their daily water management. (please mark only one response)

4 Strongly agree
8 Agree
6 No opinion
6 Disagree
1 Strongly disagree

13. The water requirements for a given crop type significantly enter into my decision making when I am choosing my crop mix. (please mark only one response)

4 Strongly agree
4 Agree
5 No opinion
9 Disagree
3 Strongly disagree

14. The agricultural community in the Salinas Valley has the cohesiveness to resolve the current water problems on it's own. (please mark only one response)

4 Strongly agree
7 Agree
2 No opinion
8 Disagree
4 Strongly disagree

15. I consider pumped water a common resource, in that each grower's use has a direct impact on other growers. (please mark only one response)

12 Strongly agree
12 Agree
0 No opinion
1 Disagree
0 Strongly disagree

NORTH VALLEY TOTAL SURVEY RESPONSES

16. I believe that a mandatory acreage set-aside program is the best water saving alternative for ensuring that an equal conservation burden is shared by all growers. (please mark only one response)
- 2 Strongly agree
 - 6 Agree
 - 1 No opinion
 - 8 Disagree
 - 8 Strongly disagree
17. I am in favor of metering wells as a means of monitoring individual water use for the purpose of allocating groundwater resources. (please mark only one response)
- 9 Strongly agree
 - 3 Agree
 - 0 No opinion
 - 5 Disagree
 - 8 Strongly disagree
18. Most growers that I know attempt to conserve groundwater, so that they will have sufficient groundwater levels 20-30 years from now. (please mark only one response)
- 5 Strongly agree
 - 11 Agree
 - 1 No opinion
 - 7 Disagree
 - 1 Strongly disagree
19. I feel there is a need to formulate a long term water management plan for the Salinas Valley. (please mark only one response)
- 16 Strongly agree
 - 7 Agree
 - 1 No opinion
 - 0 Disagree
 - 1 Strongly disagree

NORTH VALLEY TOTAL SURVEY RESPONSES

20. Who do you feel should take the leadership role in management of water resources in the Salinas Valley? (please mark only one response)

- 8 Monterey County Water Resources Agency
- 0 County Board of Supervisors
- 6 Board of Directors of the Monterey County Water Resources Agency
- 0 State Water Resources Control Board
- 5 Salinas Valley Water Advisory Commission
- 3 Individual Growers
- 3 Other: 1-All of the above, 1-Equal group of growers, 1-All of the above except state

21. (IMPORTANT) Are there some actual physical or technological constraints which are stopping you from conserving additional water? (Manpower, time, efficiency limitations of sprinkler systems, etc.)

- 6 - Financial ability to implement available systems.
- 3 - Limits of existing technology.
- 2 - Time to implement new systems.
- 1 - Landlord will not agree to allow improvements to land.

22. (IMPORTANT) What financial considerations hinder you most from conserving additional water? (Cost of capital, overhead costs, etc.)

- 17 - Cost of capital.
- 3 - Overhead costs limit ability to implement new systems.
- 3 - Low profit margins limit my ability to implement new systems.
- 2 - Installation costs prohibitive.
- 1 - Return on investment.

23. (IMPORTANT) What are the key political obstacles inhibiting better agricultural water management in the valley? (Lobbies, consensus, etc.)

- 4 - Lack of cooperation between north and south county growers.
- 4 - Inactivity of the Board of Supervisors. (Leadership)
- 3 - Lack of consensus on how to solve water problems.
- 2 - Fear of Government intervention.
- 1 - Environmental interest groups opposition to new water projects.
- 1 - Bureaucracy is slowing down progress in resolving water problems.

NORTH VALLEY TOTAL SURVEY RESPONSES

24. What water conservation investments or changes in water management practices have you made in the last five years, and why did you do so?

- 7 - Increased use of drip irrigation.
- 7 - More sprinkler systems. (improvements to existing systems)
- 4 - Tailwater return systems.
- 3 - New plastic pipelines.
- 2 - Installed water meters in new wells.
- 2 - Laser leveling/land leveling.
- 2 - Night/offwind irrigation.

25. What are the two most important concerns you have regarding the future of your agricultural water supplies?

- 13 - Quantity.
- 10 - Quality.
- 6 - Lack of new sources.
- 3 - Government Restrictions.
- 3 - Higher water costs.
- 1 - Forced metering.

26. Assuming the drought persists, what water conservation measure do you think would yield the greatest savings of groundwater?

- 10 - Set-aside.
- 5 - Increased use of drip irrigation.
- 4 - Metering of all wells.
- 4 - Improved irrigation practices.
- 2 - Mandatory rationing of water resources.
- 1 - Allocation for all growers.

27. How would you like to see the current water problems resolved?

- 13 - A new reservoir.
- 4 - Cooperation between the North and South valley growers.
- 4 - Moratorium on all new water use.
- 3 - Metering of all wells.
- 2 - Absolute rationing of water resources.
- 2 - Desalination for urban use.
- 1 - More conservation and improved practices.

APPENDIX C SOUTH SUB-CATEGORY

SOUTH VALLEY TOTAL SURVEY RESPONSES

**AGRICULTURAL
WATER MANAGEMENT SURVEY**

1. 26 Male
1 Female
2. Age: (2) 20-29 years old, (16) 30-39 years old, (17) 40-49 years old, (7) 50-59 years old, (8) 60-69 years old, (1) 70-79 years old, and (1) no answer
3. Ethnic background: 18-Caucasian, 2-German, 1-Italian, 1-Mexican, 1-European, 1-Swiss, 1-Danish, and 2-none
4. Highest level of education completed: (please mark only one response)

0 Grammar school level
9 High school level
15 B.S./B.A.
2 M.S./M.A.
1 Ph.D.
5. Political party affiliation: (please mark only one response)

3 Democratic party
20 Republican party
4 Other: 4-Non Affiliated
6. Please mark the agricultural and/or water interest groups you belong to: (please mark those responses that apply)

19 Monterey County Farm Bureau
9 Grower Shipper Vegetable Association
4 Salinas Valley Water Advisory Commission
5 M.C. Agricultural Water Conservation Task Force
10 Salinas Valley Water Coalition
5 Other 2-Grape Grower's Assn., 1-M.C. Cattleman's Assn., 1-Irrigation Assn., 1-Western Grower's Assn.

SOUTH VALLEY TOTAL SURVEY RESPONSES

7. With regard to this farm, I am: (please mark only one response)

- 6 Owner and sole proprietor
- 4 Tenant farmer
- 6 Farm manager for a corporate enterprise
- 1 Farm manager for a non-corporate partnership
- 8 Both own and lease farmland
- 2 Other: 1-Field Researcher, 1-General Partner

8. I believe that the Salinas Valley groundwater basin is served by: (please mark only one response)

- 14 A single common aquifer of varying depths
- 12 Unique isolated aquifers in various locations
- 0 Underground springs that are the source of groundwater
- 1 Other: 1-All of the above

9. The major cause of the valley's seawater intrusion is: (please mark only one response)

- 8 Excessive pumping by coastal growers
- 17 Valley-wide overdrafting of the underground aquifer
- 1 A change to water intensive crops valley-wide
- 0 Seawater intrusion isn't a serious problem
- 0 A change to water intensive crops by coastal growers
- 1 Other: 1-Ag plus Urban Overuse

10. I stay informed on water management issues by: (indicate and rank all those that apply, beginning with 1 for the most used)

- | | | | |
|---|--|-----------|-------|
| 7 | Newspaper | (ranking) | _____ |
| 2 | "Coffee shop" conversations | (ranking) | _____ |
| 0 | TV news programs | (ranking) | _____ |
| 0 | Radio | (ranking) | _____ |
| 2 | Magazines | (ranking) | _____ |
| 3 | Newsletters | (ranking) | _____ |
| 8 | Attendance at public meetings | (ranking) | _____ |
| 5 | Other: | (ranking) | _____ |
| | 2-MCWRA contacts, 2-No answer, 1-Farm Bureau contact | | |

SOUTH VALLEY TOTAL SURVEY RESPONSES

11. We are in danger of depleting the groundwater reserves in the valley as we end this fifth year of drought. (please mark only one response)

6 Strongly agree
8 Agree
2 No opinion
10 Disagree
1 Strongly disagree

12. I observe that my neighboring growers are very diligent in their daily water management. (please mark only one response)

1 Strongly agree
11 Agree
9 No opinion
5 Disagree
1 Strongly disagree

13. The water requirements for a given crop type significantly enter into my decision making when I am choosing my crop mix. (please mark only one response)

5 Strongly agree
7 Agree
4 No opinion
6 Disagree
5 Strongly disagree

14. The agricultural community in the Salinas Valley has the cohesiveness to resolve the current water problems on it's own. (please mark only one response)

5 Strongly agree
7 Agree
0 No opinion
10 Disagree
5 Strongly disagree

15. I consider pumped water a common resource, in that each grower's use has a direct impact on other growers. (please mark only one response)

10 Strongly agree
12 Agree
1 No opinion
4 Disagree
0 Strongly disagree

SOUTH VALLEY TOTAL SURVEY RESPONSES

16. I believe that a mandatory acreage set-aside program is the best water saving alternative for ensuring that an equal conservation burden is shared by all growers. (please mark only one response)
- 6 Strongly agree
 - 4 Agree
 - 0 No opinion
 - 10 Disagree
 - 7 Strongly disagree
17. I am in favor of metering wells as a means of monitoring individual water use for the purpose of allocating groundwater resources. (please mark only one response)
- 1 Strongly agree
 - 5 Agree
 - 3 No opinion
 - 10 Disagree
 - 8 Strongly disagree
18. Most growers that I know attempt to conserve groundwater, so that they will have sufficient groundwater levels 20-30 years from now. (please mark only one response)
- 4 Strongly agree
 - 8 Agree
 - 4 No opinion
 - 10 Disagree
 - 1 Strongly disagree
19. I feel there is a need to formulate a long term water management plan for the Salinas Valley. (please mark only one response)
- 21 Strongly agree
 - 3 Agree
 - 0 No opinion
 - 2 Disagree
 - 1 Strongly disagree

SOUTH VALLEY TOTAL SURVEY RESPONSES

20. Who do you feel should take the leadership role in management of water resources in the Salinas Valley? (please mark only one response)

- 4 Monterey County Water Resources Agency
- 1 County Board of Supervisors
- 7 Board of Directors of the Monterey County Water Resources Agency
- 0 State Water Resources Control Board
- 5 Salinas Valley Water Advisory Commission
- 5 Individual Growers
- 5 Other: 2-All of the above except the State, 2-No answer, 1-All of the above except the MCWRA

21. (IMPORTANT) Are there some actual physical or technological constraints which are stopping you from conserving additional water? (Manpower, time, efficiency limitations of sprinkler systems, etc.)

- 2 - Available time to install new systems.
- 2 - Profit margins are too slim to justify implementation of new projects.
- 1 - Limits of existing technology.
- 1 - Manpower limitations.
- 1 - Financial ability to implement available systems.

22. (IMPORTANT) What financial considerations hinder you most from conserving additional water? (Cost of capital, overhead costs, etc.)

- 12 - Cost of capital.
- 5 - Slim profit margins limit my ability to invest in new projects.
- 3 - Overhead costs limit my ability to implement new systems.
- 3 - Landowners are unwilling to share in the cost of new conservation.
- 1 - Banks are unwilling to loan money for conservation projects.

SOUTH VALLEY TOTAL SURVEY RESPONSES

23. (IMPORTANT) What are the key political obstacles inhibiting better agricultural water management in the valley? (Lobbies, consensus, etc.)
- 4 - Lack of cooperation between north and south county growers.
 - 4 - Fear of Government intervention. (Forced metering/taxation)
 - 4 - Lack of knowledge on water issues by some parties.
 - 3 - Self interested attitudes on the part of all parties.
 - 3 - Urban versus agriculture priority on water use.
24. What water conservation investments or changes in water management practices have you made in the last five years, and why did you do so?
- 11 - Conversion to drip irrigation.
 - 6 - More sprinkler systems. (improvements to existing systems)
 - 4 - Acreage set-aside program.
 - 4 - Night/offwind irrigation.
 - 4 - Soil moisture meters.
 - 3 - Tailwater return systems.
 - 2 - Laser leveling/land leveling.
25. What are the two most important concerns you have regarding the future of your agricultural water supplies?
- 13 - Quantity.
 - 10 - Quality.
 - 5 - Government intervention. (forced metering/restrictions)
 - 3 - Higher water costs.
 - 3 - Agricultural versus urban water priorities.
 - 2 - Seawater intrusion.
26. Assuming the drought persists, what water conservation measure do you think would yield the greatest savings of groundwater?
- 13 - Mandatory acreage set aside.
 - 5 - More conversion to drip irrigation.
 - 3 - Expanded conservation measures.
 - 2 - A building moratorium on all new water use.
 - 2 - Allocation. (fair)

SOUTH VALLEY TOTAL SURVEY RESPONSES

27. How would you like to see the current water problems resolved?

- 14 - A new reservoir.
- 7 - A mandatory set aside program.
- 4 - Allocation formula. (fair)
- 4 - Metering of all wells.
- 3 - Education and awareness.

APPENDIX D LARGE SUB-CATEGORY

LARGE SUB-CATEGORY TOTAL SURVEY RESPONSES

**AGRICULTURAL
WATER MANAGEMENT SURVEY**

1. 19 Male
1 Female
2. Age: (11) 30-39 years old, (6) 40-49 years old, (1) 50-59 years old, (2) 60-69 years old
3. Ethnic background: 18-Caucasian, 1-German, 1 Japanese-American
4. Highest level of education completed: (please mark only one response)

0 Grammar school level
4 High school level
14 B.S./B.A.
1 M.S./M.A.
5. Political party affiliation: (please mark only one response)

1 Democratic party
16 Republican party
3 Other: 1-Libertarian, 2-Non affiliated
6. Please mark the agricultural and/or water interest groups you belong to: (please mark those responses that apply)

14 Monterey County Farm Bureau
13 Grower Shipper Vegetable Association
6 Salinas Valley Water Advisory Commission
5 M.C. Agricultural Water Conservation Task Force
6 Salinas Valley Water Coalition
4 Other: 1-Iceberg Lettuce Research, 1-Western Grower's Assn., 2-M.C. Grape Growers Assn.

LARGE SUB-CATEGORY TOTAL SURVEY RESPONSES

7. With regard to this farm, I am: (please mark only one response)

- 3 Owner and sole proprietor
- 3 Tenant farmer
- 4 Farm manager for a corporate enterprise
- 2 Farm manager for a non-corporate partnership
- 8 Both own and lease farmland
- 0 Other:

8. I believe that the Salinas Valley groundwater basin is served by: (please mark only one response)

- 7 A single common aquifer of varying depths
- 12 Unique isolated aquifers in various locations
- 0 Underground springs that are the source of groundwater
- 1 Other: 1-All of the above

9. The major cause of the valley's seawater intrusion is: (please mark only one response)

- 4 Excessive pumping by coastal growers
- 15 Valley-wide overdrafting of the underground aquifer
- 0 A change to water intensive crops valley-wide
- 0 Seawater intrusion isn't a serious problem
- 0 A change to water intensive crops by coastal growers
- 1 Other: 1-Ag plus urban overuse

10. I stay informed on water management issues by: (indicate and rank all those that apply, beginning with 1 for the most used)

- | | | | |
|---|---------------------------------|-----------|-------|
| 7 | Newspaper | (ranking) | _____ |
| 1 | "Coffee shop" conversations | (ranking) | _____ |
| 0 | TV news programs | (ranking) | _____ |
| 0 | Radio | (ranking) | _____ |
| 0 | Magazines | (ranking) | _____ |
| 2 | Newsletters | (ranking) | _____ |
| 8 | Attendance at public meetings | (ranking) | _____ |
| 2 | Other: | (ranking) | _____ |
| | 1-MCWRA contacts, 1-Farm Bureau | | |

LARGE SUB-CATEGORY TOTAL SURVEY RESPONSES

11. We are in danger of depleting the groundwater reserves in the valley as we end this fifth year of drought. (please mark only one response)

5 Strongly agree
8 Agree
0 No opinion
7 Disagree
0 Strongly disagree

12. I observe that my neighboring growers are very diligent in their daily water management. (please mark only one response)

2 Strongly agree
10 Agree
5 No opinion
3 Disagree
0 Strongly disagree

13. The water requirements for a given crop type significantly enter into my decision making when I am choosing my crop mix. (please mark only one response)

4 Strongly agree
2 Agree
3 No opinion
7 Disagree
4 Strongly disagree

14. The agricultural community in the Salinas Valley has the cohesiveness to resolve the current water problems on it's own. (please mark only one response)

2 Strongly agree
5 Agree
2 No opinion
6 Disagree
5 Strongly disagree

15. I consider pumped water a common resource, in that each grower's use has a direct impact on other growers. (please mark only one response)

8 Strongly agree
9 Agree
0 No opinion
3 Disagree
0 Strongly disagree

LARGE SUB-CATEGORY TOTAL SURVEY RESPONSES

16. I believe that a mandatory acreage set-aside program is the best water saving alternative for ensuring that an equal conservation burden is shared by all growers. (please mark only one response)
- 4 Strongly agree
 - 3 Agree
 - 0 No opinion
 - 5 Disagree
 - 8 Strongly disagree
17. I am in favor of metering wells as a means of monitoring individual water use for the purpose of allocating groundwater resources. (please mark only one response)
- 5 Strongly agree
 - 4 Agree
 - 1 No opinion
 - 2 Disagree
 - 8 Strongly disagree
18. Most growers that I know attempt to conserve groundwater, so that they will have sufficient groundwater levels 20-30 years from now. (please mark only one response)
- 2 Strongly agree
 - 9 Agree
 - 1 No opinion
 - 7 Disagree
 - 1 Strongly disagree
19. I feel there is a need to formulate a long term water management plan for the Salinas Valley. (please mark only one response)
- 15 Strongly agree
 - 3 Agree
 - 0 No opinion
 - 2 Disagree
 - 0 Strongly disagree

LARGE SUB-CATEGORY TOTAL SURVEY RESPONSES

20. Who do you feel should take the leadership role in management of water resources in the Salinas Valley? (please mark only one response)

- 5 Monterey County Water Resources Agency
- 1 County Board of Supervisors
- 5 Board of Directors of the Monterey County Water Resources Agency
- 0 State Water Resources Control Board
- 4 Salinas Valley Water Advisory Commission
- 2 Individual Growers
- 3 Other: 2-All of the above, 1-No answer

21. (IMPORTANT) Are there some actual physical or technological constraints which are stopping you from conserving additional water? (Manpower, time, efficiency limitations of sprinkler systems, etc.)

- 5 - Limits of existing technology (irrigation)
- 2 - Time required to install new systems
- 2 - Profit margins are too slim to justify new systems
- 2 - Cost recovery of conversion to new technology takes too long to justify at the present time
- 1 - Landlord will not share in the cost of implementing new conservation technology

22. (IMPORTANT) What financial considerations hinder you most from conserving additional water? (Cost of capital, overhead costs, etc.)

- 10 - Cost of capital
- 5 - Low profit margins limit my ability to implement new systems
- 2 - Overhead costs limit ability to implement new systems
- 2 - Installation costs prohibitive
- 1 - Return on investment too low in the short run to justify new conservation

23. (IMPORTANT) What are the key political obstacles inhibiting better agricultural water management in the valley? (Lobbies, consensus, etc.)

- 6 - Lack of cooperation between north and south county growers.
- 2 - Unwillingness of landowners to bear some of the costs of conservation.
- 2 - Lack of consensus on how to solve water problems.
- 2 - Failure of the County Board of Supervisors to show leadership in agricultural water management.

LARGE SUB-CATEGORY TOTAL SURVEY RESPONSES

24. What water conservation investments or changes in water management practices have you made in the last five years, and why did you do so?

- 10 - Increased use of drip irrigation.
- 6 - More sprinkler systems. (improvements to existing systems)
- 3 - Tailwater return systems.
- 3 - New plastic pipelines.
- 2 - Night/offwind irrigation. (PG&E program)
- 2 - Neutron probe system.

25. What are the two most important concerns you have regarding the future of your agricultural water supplies?

- 10 - Quantity.
- 8 - Quality.
- 4 - Threat of seawater intrusion.
- 3 - Higher water costs.
- 2 - Lack of new sources.
- 1 - Government intervention. (restrictions)

26. Assuming the drought persists, what water conservation measure do you think would yield the greatest savings of groundwater?

- 10 - Set-aside.
- 4 - Increased use of drip irrigation.
- 4 - Improved irrigation practices.
- 2 - Mandatory rationing of water resources.
- 2 - Allocation for all growers.
- 2 - Metering of all wells.

27. How would you like to see the current water problems resolved?

- 10 - A new reservoir.
- 5 - Develop a water management plan.
- 4 - Mandatory set-aside. (interim measure)
- 4 - Cooperation between North and South/positive leadership.
- 3 - Metering of all wells.
- 2 - Absolute rationing of water resources.
- 2 - Allocation formula. (fair)

APPENDIX E MEDIUM SUB-CATEGORY

MEDIUM SUB-CATEGORY TOTAL SURVEY RESPONSES

**AGRICULTURAL
WATER MANAGEMENT SURVEY**

1. 7 Male
0 Female
2. Age: (1) 20-29 years old, (2) 40-49 years old, (1) 50-59 years old, (2) 60-69 years old, (1) No age
3. Ethnic background: 3-Caucasian, 1-German, 1-Swiss, 2-European
4. Highest level of education completed: (please mark only one response)

0 Grammar school level
2 High school level
4 B.S./B.A.
1 M.S./M.A.
5. Political party affiliation: (please mark only one response)

0 Democratic party
5 Republican party
2 Other: 1-Libertarian, 1-Non affiliated
6. Please mark the agricultural and/or water interest groups you belong to: (please mark those responses that apply)

5 Monterey County Farm Bureau
4 Grower Shipper Vegetable Association
1 Salinas Valley Water Advisory Commission
1 M.C. Agricultural Water Conservation Task Force
2 Salinas Valley Water Coalition
3 Other: 1-Backflow Comm., 1-Nitrate Comm., 1-M.C. Ag Education V.P.

MEDIUM SUB-CATEGORY TOTAL SURVEY RESPONSES

7. With regard to this farm, I am: (please mark only one response)

- 1 Owner and sole proprietor
- 1 Tenant farmer
- 2 Farm manager for a corporate enterprise
- 1 Farm manager for a non-corporate partnership
- 2 Both own and lease farmland
- 0 Other:

8. I believe that the Salinas Valley groundwater basin is served by: (please mark only one response)

- 4 A single common aquifer of varying depths
- 3 Unique isolated aquifers in various locations
- 0 Underground springs that are the source of groundwater
- 0 Other:

9. The major cause of the valley's seawater intrusion is: (please mark only one response)

- 1 Excessive pumping by coastal growers
- 6 Valley-wide over 'rafting of the underground aquifer
- 0 A change to water intensive crops valley-wide
- 0 Seawater intrusion isn't a serious problem
- 0 A change to water intensive crops by coastal growers
- 0 Other:

10. I stay informed on water management issues by: (indicate and rank all those that apply, beginning with 1 for the most used)

- 1 Newspaper (ranking) _____
- 0 "Coffee shop" conversations (ranking) _____
- 0 TV news programs (ranking) _____
- 0 Radio (ranking) _____
- 1 Magazines (ranking) _____
- 1 Newsletters (ranking) _____
- 3 Attendance at public meetings (ranking) _____
- 1 Other: (ranking) _____
- 1-MCWRA contacts

MEDIUM SUB-CATEGORY TOTAL SURVEY RESPONSES

11. We are in danger of depleting the groundwater reserves in the valley as we end this fifth year of drought. (please mark only one response)
- 2 Strongly agree
 - 0 Agree
 - 1 No opinion
 - 4 Disagree
 - 0 Strongly disagree
12. I observe that my neighboring growers are very diligent in their daily water management. (please mark only one response)
- 1 Strongly agree
 - 1 Agree
 - 2 No opinion
 - 2 Disagree
 - 1 Strongly disagree
13. The water requirements for a given crop type significantly enter into my decision making when I am choosing my crop mix. (please mark only one response)
- 0 Strongly agree
 - 3 Agree
 - 0 No opinion
 - 2 Disagree
 - 2 Strongly disagree
14. The agricultural community in the Salinas Valley has the cohesiveness to resolve the current water problems on it's own. (please mark only one response)
- 0 Strongly agree
 - 3 Agree
 - 0 No opinion
 - 4 Disagree
 - 0 Strongly disagree
15. I consider pumped water a common resource, in that each grower's use has a direct impact on other growers. (please mark only one response)
- 2 Strongly agree
 - 5 Agree
 - 0 No opinion
 - 0 Disagree
 - 0 Strongly disagree

MEDIUM SUB-CATEGORY TOTAL SURVEY RESPONSES

16. I believe that a mandatory acreage set-aside program is the best water saving alternative for ensuring that an equal conservation burden is shared by all growers. (please mark only one response)
- 1 Strongly agree
 - 2 Agree
 - 0 No opinion
 - 3 Disagree
 - 1 Strongly disagree
17. I am in favor of metering wells as a means of monitoring individual water use for the purpose of allocating groundwater resources. (please mark only one response)
- 1 Strongly agree
 - 2 Agree
 - 0 No opinion
 - 3 Disagree
 - 1 Strongly disagree
18. Most growers that I know attempt to conserve groundwater, so that they will have sufficient groundwater levels 20-30 years from now. (please mark only one response)
- 1 Strongly agree
 - 3 Agree
 - 1 No opinion
 - 1 Disagree
 - 1 Strongly disagree
19. I feel there is a need to formulate a long term water management plan for the Salinas Valley. (please mark only one response)
- 5 Strongly agree
 - 2 Agree
 - 0 No opinion
 - 0 Disagree
 - 0 Strongly disagree

MEDIUM SUB-CATEGORY TOTAL SURVEY RESPONSES

20. Who do you feel should take the leadership role in management of water resources in the Salinas Valley? (please mark only one response)

- 0 Monterey County Water Resources Agency
- 0 County Board of Supervisors
- 5 Board of Directors of the Monterey County Water Resources Agency
- 0 State Water Resources Control Board
- 1 Salinas Valley Water Advisory Commission
- 0 Individual Growers
- 1 Other: 1-All of the above

21. (IMPORTANT) Are there some actual physical or technological constraints which are stopping you from conserving additional water? (Manpower, time, efficiency limitations of sprinkler systems, etc.)

- 3 - Financial ability to implement available systems.
- 1 - Limits of existing technology. (irrigation)

22. (IMPORTANT) What financial considerations hinder you most from conserving additional water? (Cost of capital, overhead costs, etc.)

- 4 - Cost of capital.
- 1 - Overhead costs limit ability to implement new systems.
- 1 - Slim profit margins do not justify new conservation investments.

23. (IMPORTANT) What are the key political obstacles inhibiting better agricultural water management in the valley? (Lobbies, consensus, etc.)

- 1 - Inactivity of Board of Supervisors.
- 1 - Bureaucracy. (regulations)
- 1 - Lack of proper representation of south county views.
- 1 - Lack of cooperation between north and south county growers.
- 1 - Delay in enacting policies.
- 1 - Environmental interest groups.

MEDIUM SUB-CATEGORY TOTAL SURVEY RESPONSES

24. What water conservation investments or changes in water management practices have you made in the last five years, and why did you do so?
- 4 - Tailwater return systems.
 - 3 - More sprinkler systems. (improvements to existing systems)
 - 2 - Laser leveling.
 - 2 - Soil moisture meters.
 - 1 - Night/offwind irrigation. (PG&E program)
25. What are the two most important concerns you have regarding the future of your agricultural water supplies?
- 5 - Quantity.
 - 5 - Quality.
 - 2 - Government intervention. (restrictions)
 - 2 - Urban versus Ag water priority.
26. Assuming the drought persists, what water conservation measure do you think would yield the greatest savings of groundwater?
- 4 - Set-aside.
 - 1 - Metering of all wells.
 - 1 - Improved water management practices.
 - 1 - Mandatory rationing of water resources.
 - 1 - Allocation for all growers.
 - 1 - Building moratorium on ag, urban and industrial use.
27. How would you like to see the current water problems resolved?
- 4 - A new reservoir.
 - 3 - Allocation formula. (fair)
 - 2 - Metering of all wells.
 - 1 - Improve existing dams.
 - 1 - Limit multiple cropping.
 - 1 - Desalination for urban use.
 - 1 - Recycle "grey water."
 - 1 - Conservation by all parties.

APPENDIX F SMALL SUB-CATEGORY

SMALL SUB-CATEGORY TOTAL SURVEY RESPONSES

**AGRICULTURAL
WATER MANAGEMENT SURVEY**

1. 25 Male
0 Female
2. Age: (1) 20-29 years old, (6) 30-39 years old, (9) 40-49 years old, (5) 50-59 years old, (3) 60-69 years old, (1) 70-79 years old
3. Ethnic background: 16-Caucasian, 1-German, 1 Japanese-American, 3-Italian, 1-Mexican, 1-Japanese, 2-No answer
4. Highest level of education completed: (please mark only one response)

0 Grammar school level
7 High school level
13 B.S./B.A.
2 M.S./M.A.
3 Other: 2-PHD, 1-No answer
5. Political party affiliation: (please mark only one response)

6 Democratic party
14 Republican party
5 Other: 3-Non affiliated, 1-Non U.S. Citizen, 1-No answer
6. Please mark the agricultural and/or water interest groups you belong to: (please mark those responses that apply)

12 Monterey County Farm Bureau
4 Grower Shipper Vegetable Association
3 Salinas Valley Water Advisory Commission
2 M.C. Agricultural Water Conservation Task Force
5 Salinas Valley Water Coalition
3 Other: 1-Irrigation Assn., 1-M.C. Cattleman's Assn., 1- CA Assn. of Family Farmers

SMALL SUB-CATEGORY TOTAL SURVEY RESPONSES

7. With regard to this farm, I am: (please mark only one response)

- 8 Owner and sole proprietor
- 3 Tenant farmer
- 5 Farm manager for a corporate enterprise
- 0 Farm manager for a non-corporate partnership
- 6 Both own and lease farmland
- 3 Other: 1-Field researcher, 1-General Partner, 1-Research Director for Seed Co.

8. I believe that the Salinas Valley groundwater basin is served by: (please mark only one response)

- 10 A single common aquifer of varying depths
- 15 Unique isolated aquifers in various locations
- 0 Underground springs that are the source of groundwater

9. The major cause of the valley's seawater intrusion is: (please mark only one response)

- 7 Excessive pumping by coastal growers
- 15 Valley-wide overdrafting of the underground aquifer
- 2 A change to water intensive crops valley-wide
- 0 Seawater intrusion isn't a serious problem
- 0 A change to water intensive crops by coastal growers
- 1 Other: 1-Drought

10. I stay informed on water management issues by: (indicate and rank all those that apply, beginning with 1 for the most used)

- 8 Newspaper (ranking) _____
- 3 "Coffee shop" conversations (ranking) _____
- 0 TV news programs (ranking) _____
- 0 Radio (ranking) _____
- 2 Magazines (ranking) _____
- 2 Newsletters (ranking) _____
- 7 Attendance at public meetings (ranking) _____
- 1 Other: (ranking) _____
- Direct contact with growers
- 2 No Answer

SMALL SUB-CATEGORY TOTAL SURVEY RESPONSES

11. We are in danger of depleting the groundwater reserves in the valley as we end this fifth year of drought. (please mark only one response)

7 Strongly agree
8 Agree
2 No opinion
7 Disagree
1 Strongly disagree

12. I observe that my neighboring growers are very diligent in their daily water management. (please mark only one response)

2 Strongly agree
8 Agree
8 No opinion
6 Disagree
1 Strongly disagree

13. The water requirements for a given crop type significantly enter into my decision making when I am choosing my crop mix. (please mark only one response)

5 Strongly agree
6 Agree
6 No opinion
6 Disagree
2 Strongly disagree

14. The agricultural community in the Salinas Valley has the cohesiveness to resolve the current water problems on it's own. (please mark only one response)

7 Strongly agree
6 Agree
0 No opinion
8 Disagree
4 Strongly disagree

15. I consider pumped water a common resource, in that each grower's use has a direct impact on other growers. (please mark only one response)

12 Strongly agree
10 Agree
1 No opinion
2 Disagree
0 Strongly disagree

SMALL SUB-CATEGORY TOTAL SURVEY RESPONSES

16. I believe that a mandatory acreage set-aside program is the best water saving alternative for ensuring that an equal conservation burden is shared by all growers. (please mark only one response)

3 Strongly agree
5 Agree
1 No opinion
10 Disagree
6 Strongly disagree

17. I am in favor of metering wells as a means of monitoring individual water use for the purpose of allocating groundwater resources. (please mark only one response)

4 Strongly agree
2 Agree
2 No opinion
10 Disagree
7 Strongly disagree

18. Most growers that I know attempt to conserve groundwater, so that they will have sufficient groundwater levels 20-30 years from now. (please mark only one response)

6 Strongly agree
7 Agree
3 No opinion
9 Disagree
0 Strongly disagree

19. I feel there is a need to formulate a long term water management plan for the Salinas Valley. (please mark only one response)

17 Strongly agree
5 Agree
1 No opinion
0 Disagree
2 Strongly disagree

SMALL SUB-CATEGORY TOTAL SURVEY RESPONSES

20. Who do you feel should take the leadership role in management of water resources in the Salinas Valley? (please mark only one response)

- 7 Monterey County Water Resources Agency
- 0 County Board of Supervisors
- 3 Board of Directors of the Monterey County Water Resources Agency
- 0 State Water Resources Control Board
- 5 Salinas Valley Water Advisory Commission
- 6 Individual Growers
- 3 Other: 2-All of the above, 1-Equal group of growers
- 1 No Answer

21. (IMPORTANT) Are there some actual physical or technological constraints which are stopping you from conserving additional water? (Manpower, time, efficiency limitations of sprinkler systems, etc.)

- 2 - Manpower limitation.
- 1 - Time required to install new systems.

22. (IMPORTANT) What financial considerations hinder you most from conserving additional water? (Cost of capital, overhead costs, etc.)

- 10 - Cost of capital.
- 2 - Overhead costs limit ability to implement new systems.
- 2 - Slim profit margins limit my ability to implement new systems.
- 1 - Bank unwilling to loan money for conservation based on slim profits.
- 1 - Landlords unwilling to share cost of conservation investments with tenants.

SMALL SUB-CATEGORY TOTAL SURVEY RESPONSES

23. (IMPORTANT) What are the key political obstacles inhibiting better agricultural water management in the valley? (Lobbies, consensus, etc.)
- 4 - Fear of government intervention by ag growers.
(meters/taxation)
 - 3 - Lack of consensus on how to solve water problems.
 - 2 - Self interest taking priority over valley-wide interest.
 - 2 - Lack of understanding of magnitude of problem.
 - 1 - Lack of proper incentives to conserve more water.
 - 1 - Ag versus urban water use priority.
 - 1 - Lack of fair representation of ag interests on Board of Supervisors.
24. What water conservation investments or changes in water management practices have you made in the last five years, and why did you do so?
- 8 - Increased use of drip irrigation.
 - 4 - 20% set-aside as per ordinance.
 - 3 - More sprinkler systems. (improvements to existing systems)
 - 2 - Flow meters/automatic shutoff valves.
 - 1 - Night/offwind irrigation. (PG&E program)
 - 1 - Laser leveling.
 - 1 - Smaller sprinkler nozzles.
 - 1 - Water return systems.
25. What are the two most important concerns you have regarding the future of your agricultural water supplies?
- 10 - Quantity.
 - 7 - Quality.
 - 5 - Threat of seawater intrusion.
 - 3 - Higher water costs.
 - 3 - Government intervention. (restrictions)
 - 3 - State intervention.
 - 1 - Forced metering.
 - 1 - Adoption of fair policies.

SMALL SUB-CATEGORY TOTAL SURVEY RESPONSES

26. Assuming the drought persists, what water conservation measure do you think would yield the greatest savings of groundwater?

- 7 - Mandatory Set-aside.
- 4 - Mandatory metering and allocation.
- 3 - Increased use of drip irrigation.
- 2 - More conservation.
- 1 - Limits on multiple cropping.
- 1 - Shift to less water intensive crops.

27. How would you like to see the current water problems resolved?

- 12 - A new reservoir.
- 4 - Mandatory set-aside. (interim measure)
- 4 - Moratorium on further ag, urban, industrial development.
- 3 - Cooperation between North and South/positive leadership.
- 3 - Education/awareness.
- 2 - Meters. (If not used to tax)
- 1 - Enlarge existing reservoirs.

LIST OF REFERENCES

1. Manning, J.C., "Resume of Ground Water Hydrology in the Salinas Valley, California," AAPG-SGPM Field Inspection, February, 1963.
2. Neagley, J.P., and O'Brien, R.T., Market Allocation of Agricultural Water Resources in the Salinas River Valley, Master's Thesis, Naval Postgraduate School, Monterey, California, December 1990.
3. Monterey County Flood Control and Water Conservation District, Water Capital Facilities Plan (Draft), v. 1, August 15, 1990.
4. DeMars, E.W., and others, Agricultural Background Study of Monterey County, Monterey County Planning Department, 1982.
5. Anderson, B., "Beginnings of Agriculture in the Salinas Valley 1770-1849," Coastal Grower, p. 32, Winter 1989.
6. Hanlsen, A., "History of Water Resources in the Salinas Valley," Presentation at the Water Symposium sponsored by Hartnell College, 11 December 1986.
7. Allen, H.H., Economic history of Agriculture in Monterey County, California During the American Period, Doctoral Dissertation, Stanford University, Palo Alto, California, 1933.
8. Anderson, B., "Salinas Valley Agriculture 1885-1919," Coastal Grower, p. 29, Summer 1989.
9. Anderson, B., "Salinas Valley Agriculture 1919-1945," Coastal Grower, p. 40, Fall 1989.
10. Anderson, B., "Salinas Valley Agriculture 1946-1970," Coastal Grower, p. 38, Winter 1990.
11. Ririe, D., "The Production of Vegetable Corps in the Salinas Valley," A talk for the Vegetable Crops Conference, Monterey County Agricultural Extension, 1983.

12. Monterey County Agricultural Commissioner, 1989 Monterey County Annual Crop Report, Monterey County Agricultural Commission, 1990.
13. Monterey County Agricultural Commissioner, 1990 Monterey County Annual Crop Report, Monterey County Agricultural Commission, 1991.
14. Lemoine, P.H., Water Resources Management in the Salinas Valley, Doctoral Dissertation, UMI, June 1984.
15. Interview with Mr. Ted Mills, Water Conservation Manager, Monterey County Water Resources Agency, 8 May 1991.
16. Bunte, B., "Water: The Life Blood of the Salinas Valley," economics research paper on file at MCWRA, 19 December 1974.
17. Anderson, T.L., (ed.), Water Rights: Scarce Resources Allocation, Bureaucracy and the Environment, Pacific Institute for Public Policy Research, 1983.
18. Sliglitz, J.E., Economics of the Public Sector, W.W. Norton & Company, New York, 1986.
19. Win, U., and Duman, J., (ed.), "Groundwater Update," Water Resources Quarterly, v. 2 no. 2, p. 6, April 1991.
20. Mills, T., "Water Issues," (Draft), Paper on Water Issues, Problems and Allocation Considerations, MCWRA, 5 September 1991.
21. Rhoads, S.E., The Economist View of the World; Government Market and Public Policy, Cambridge University Press, 1985.
22. Bullis, K.C., and others, Environmental Constraints Analysis of Monterey County: Part III, Air and Water Quality, Monterey County Planning Department, April 1981.
23. Dillman, D.A., Mail and Telephone Surveys: The Total Design Method, John Wiley & Sons, Inc., 1978.
24. Miller, W.J., The Salinas Valley Seawater Intrusion Program, Seawater Intrusion Commission, January 1987.

BIBLIOGRAPHY

1. Alwin, D.F., Survey Design and Analysis: Current Issues, Sage Publishing, 1978.
2. Anderson, B., "The Drought Periods in the Salinas Valley Since 1770 and Their Effect on Monterey County Agriculture," Coastal Grower, Spring 1990.
3. Arnold, C., Monterey County Irrigation Water Management Program Evaluation, Monterey County Water Resources Agency, 1988.
4. Barker, W.H., (ed.), "Tailwater Recovery: Offers Benefits," Farm Focus, vol. 9, no. 3, p. 15, Summer 1991.
5. Benoit, J., and Filippini, M., (ed.), Water Conservation Plan for Monterey County, Monterey County Flood Control and Water Conservation District, March 1989.
6. Brickson, B., "Agricultural Water Use," Western Water, January/February 1991.
7. Davis, J.A., Elementary Survey Analysis, Prentice-Hall, Inc., 1971.
8. Miller, B.J., The Salinas Valley Seawater Intrusion Program, Monterey County Flood Control District and Water Conservation District, January 1987.
9. Moses T., "Ag Task Force Update," Farm Focus, vol. 8, no. 3, p. 6, Summer 1990.
10. Rosenberg, M., The Logic of Survey Analysis, Basic Books, Inc., 1968.
11. Sudman, R., (ed.), "A Conversation With Marc Reisner," Western Water, January/February 1991.

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